

# Lab Manager<sup>®</sup> MAGAZINE

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November 2011

Product Resource Guide

# 2012 PRODUCT RESOURCE GUIDE

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Application: Dispersing of  
mint leaves.

**Step 2**  
The tube is attached  
onto the drive  
system.



**Step 3**  
The mint leaves are homo-  
genized by the rotor-stator  
unit in the DT Tube.



**Step 4**  
Test result: The mint leaves  
are dispersed homogeneously.  
The tube is removed from the  
drive system.



**Step 5**  
If required the sample can be  
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syringe through the pierceable  
membrane of the tube lid.



**Step 6**  
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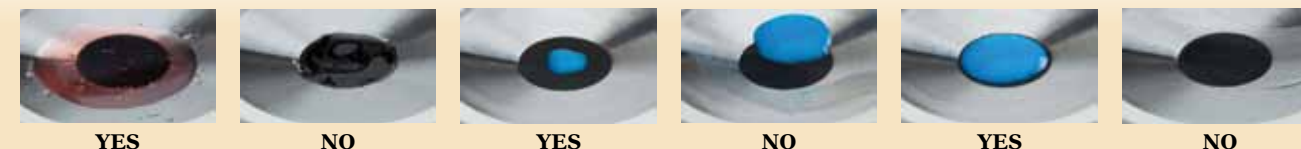
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8

Laboratory Spending Trends

To better ascertain spending trends among laboratories, the editors of *Lab Manager Magazine* and Frost & Sullivan recently conducted a survey of 146 *Lab Manager Magazine* readers who were qualified as decision makers who either influence or approve their laboratory purchasing policies. Here are the results.

Jonathan Witonsky

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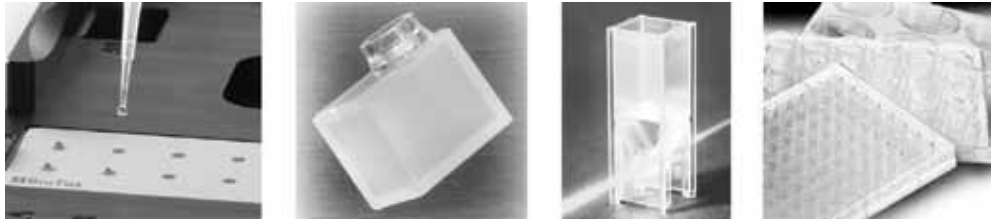
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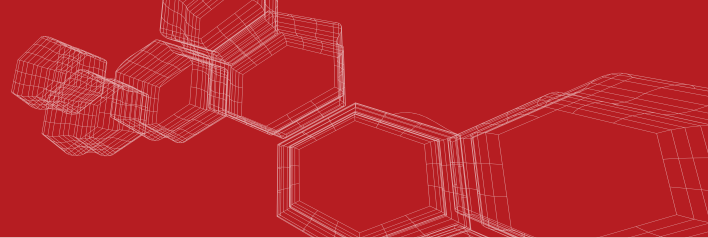
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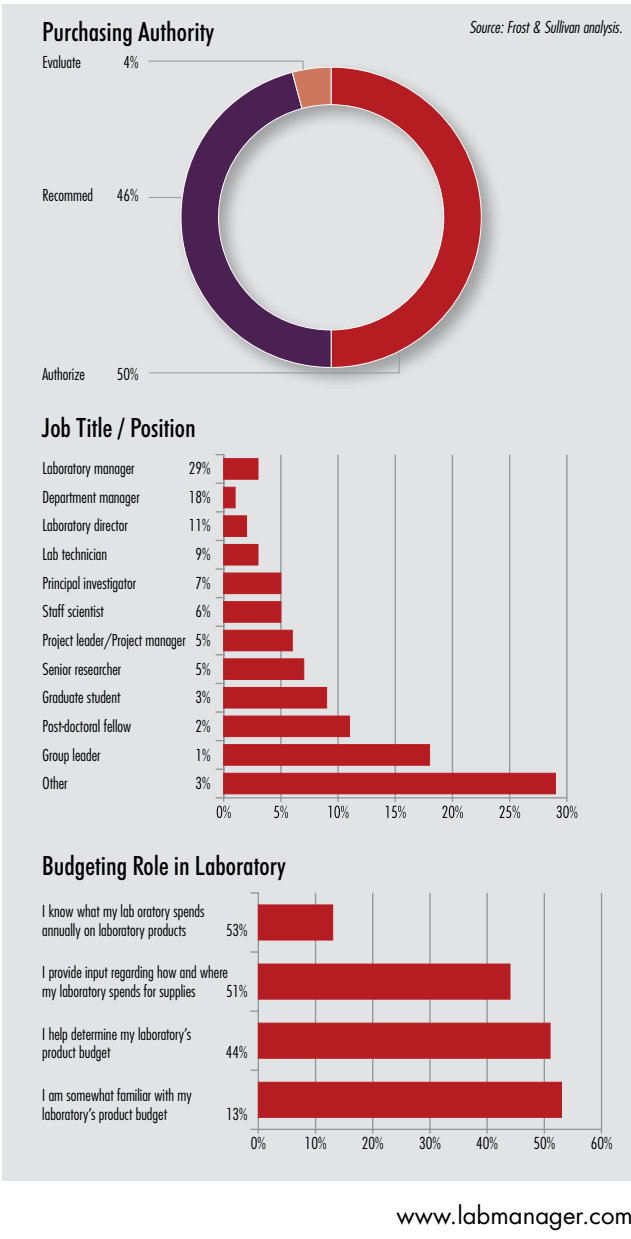
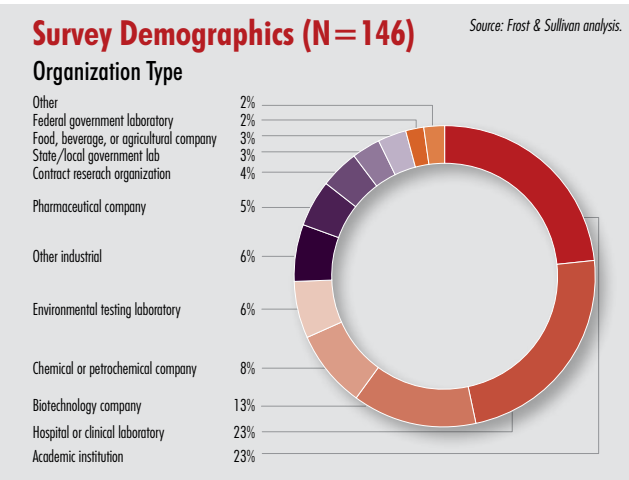




# LABORATORY SPENDING TRENDS

**SURVEY RESULTS FORECAST  
FLAT BUDGETS AND LIMITED  
SPENDING INCREASES**  
by Jonathan Witonsky

In addition to managing the day-to-day operations and challenges of their laboratories, laboratory managers are now confronted with an increasingly volatile budgeting process. When compared to the early part of last decade, which was shaped by dependable and steady growth, the past three years are easily characterized as uncertain and, at times, tumultuous with numerous market swings. The economic stimulus package and a relaxation of purchasing freezes in late 2009 and early 2010 seemed to indicate a return to normalcy. Nevertheless, there are few signs signifying that annual increases in research and development spending will return to their historical levels of 5% to 10%, at least not any time soon. To better ascertain the spending trends among laboratories, the editors of *Lab Manager Magazine* and Frost & Sullivan recently conducted a survey of 146 *Lab Manager Magazine* readers who were qualified as decision makers who either influence or approve their laboratory purchasing policies. Survey respondents primarily include laboratory managers, department managers, laboratory directors, laboratory technicians, and principal investigators at academic institutions, hospitals or clinical laboratories, biotechnology companies, and chemical or petrochemical companies globally.



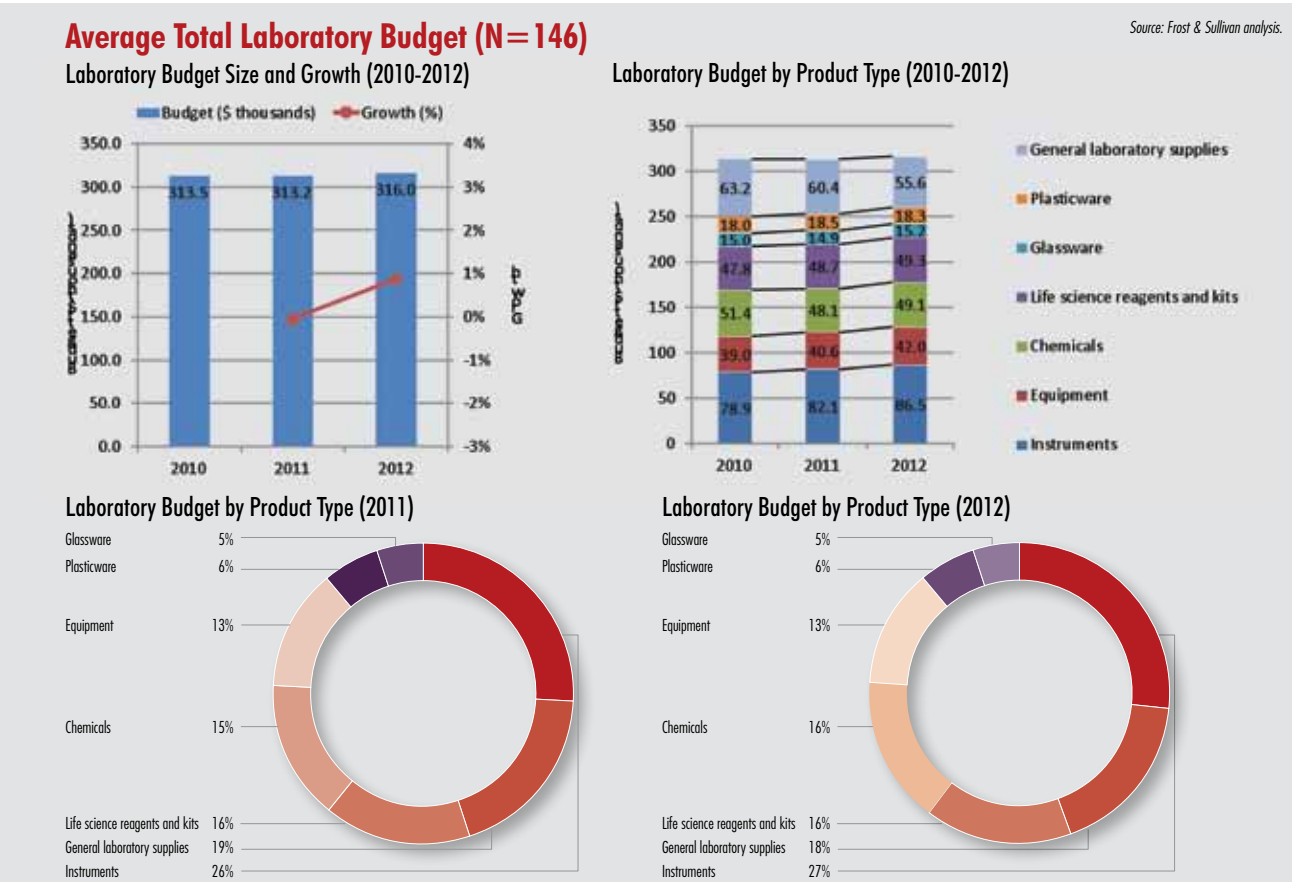
## Flat budgets abound

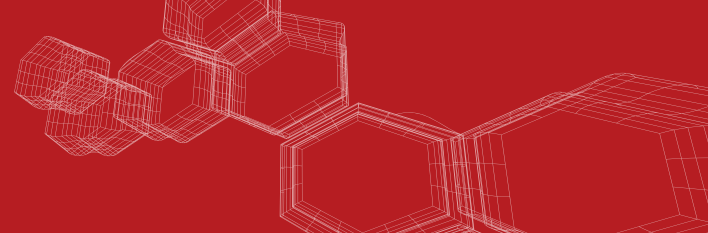
When spending levels increased in late 2009 and 2010, general sentiments were that a recovery was taking place. In retrospect, it seems that a lot of this spending was the result of pent-up demand: excessively conservative laboratories were left with depleted inventories and instruments or equipment that was in dire need of replacement. Moreover, the infusion of approximately \$10 billion in federal stimulus funding for research—provided through the American Recovery and Reinvestment Act of 2009—further inflated expectations and promoted unjustified optimism. While spending increases in 2010 were similar to or higher than increases seen in 2007 and earlier, 2011 by comparison is flat. In 2010, the average total laboratory budget among the 146 *Lab Manager Magazine* readers surveyed was \$313,500. Representing a slight decline, their budgets averaged \$313,200 in 2011. The outlook for 2012 is not terribly positive as survey respondents expect only a modest increase of roughly 1%, to \$316,000. The explanation for the spending slowdown is consistent: budget cuts. The reasons for these cuts, however, are varied. Respondents cite the general recession, reductions in state or city funding, the falling number of federal grants, and consolidation due to corporate mergers and takeovers as the reasons for their reduced spending power.

The majority of spending—over 60%—is on consumables: chemicals, life science reagents and kits, glassware, plasticware,

and general laboratory supplies. Investment in these products is expected to remain stable between 2011 and 2012, with as much as 19% of budgets allocated to the purchase of general laboratory supplies, 16% allocated to the purchase of chemicals, 16% allocated to the purchase of life science reagents and kits, 6% allocated to the purchase of plasticware, and 5% allocated to the purchase of glassware. Despite the rising costs of raw materials essential to the production of consumables, laboratories set aside a relatively constant portion of their budgets for these products. While vendors are eager to raise consumables pricing to cover their increasing manufacturing costs, laboratories have successfully leveraged their buying power to minimize price increases.

Instruments and equipment make up as much as 40% of the remaining spending, with up to 27% of budgets allocated to the purchase of instruments and 13% allocated to the purchase of equipment. Instruments are the single largest expense of laboratories, with the average instrument budget totaling over \$82,000 in 2011. Survey respondents recognize that a larger investment in more sophisticated instrumentation with greater sensitivity and higher throughput can improve their laboratories' efficiencies by enhancing analytical capabilities, expanding applications, or reducing costs associated with staffing or sample volumes. Accordingly, survey respondents plan to boost spending on instrumentation by 5.4% in 2012, raising their average instrument expenditure to \$86,500.





### Fluctuations in product spending

General laboratory supplies—products such as filtration membranes, gloves, wipes, clothing, absorbents, dispensers, cans, syringes, and disposable bioreactors—are the largest consumables expense. On average, surveyed laboratories allocated \$60,400 toward the purchase of these products. However, given the wide diversity of general laboratory supplies, a product-specific analysis was not conducted. Among all product categories, budget cuts are expected to have the greatest impact on spending for general laboratory supplies. Compared to 2010, average spending for these products declined by 4.4% in 2011, and in 2012, surveyed laboratories are planning for another 7.9% cut.

On average, laboratories spend \$48,700 on life science reagents and kits, the second-largest consumables expense. While survey respondents' budgets for life science reagents and kits increased by only about 1.9% in 2011, sales of these products are generally viewed as one of the fastest-growing product categories, given biopharmaceutical companies' and academic institutions' increased focus in genomics research and protein biomarker discovery. Life science reagents and kits are the least commonly employed laboratory products, with only 70% of respondents (N=103) claiming to have used them in 2011. However, this represents a sizable increase over 2010, when only 54% of respondents (N=79) used life science reagents and kits in their laboratories. Average budgets for immunochemicals, cell culture reagents, and nucleic acid research reagents are similar at \$10,700, \$9,700, and \$8,800, respectively. Protein research reagents and cell analysis research reagents warrant smaller average investments of \$4,900 and \$3,900, respectively, and an average of \$11,200 is allocated to the purchase of all other life science reagents and kits.

Spending on chemicals, which averaged \$48,100 in 2011, is the third-largest consumables expenditure among surveyed laboratories. Respondents reduced the portion of their budget allocated to chemicals purchases by 6.4% in 2011—the greatest decrease among all product categories. However, respondents plan to increase their chemicals purchases by 2.1% in 2012. The decline in 2011 is likely attributable to an overstocking of chemicals in 2010—a result of an overcorrection in purchasing during the previous downturn year. Standard laboratory chemicals, such as solvents, acids, standards, and dyes, make up the far majority of chemicals spending: in 2011, survey respondents spent an average of \$34,600 on standard chemicals. Laboratories plan to

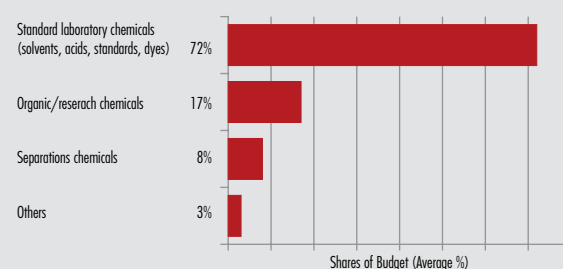
spend the remainder of their chemicals budget on organic/research chemicals (\$8,200), separation chemicals (\$3,800), and other chemicals (\$1,400).

Budgets for plasticware averaged \$18,500 in 2011, a 2.8% increase over the previous year. Respondents expect their 2012 plasticware budgets to undergo a small contraction of 1.1% in 2012. Most of this spending is on liquid-handling plasticware, for which respondents budgeted approximately \$10,200. Other plasticware purchases include cell culture and bioprocessing plastic and high-throughput screening plasticware, which averaged \$4,800 and \$1,500, respectively. However, average budgets for the latter two categories of plasticware are considerably higher among biopharmaceutical laboratories.

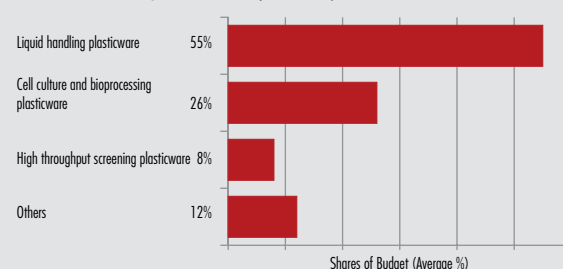
The average budget for glassware, the final consumables product category, totaled \$14,900 in 2011, a 0.7% decline compared to 2010. In 2012, respondents expect their glassware budget to increase by roughly 2%. Glassware purchases have been declining for several years, independent of the economic downturn in 2008 and 2009. Nevertheless, glassware is still critical to laboratory processes, especially reusable glassware, for which respondents' budgets averaged \$8,300. Other glassware purchases include disposable glassware and specialty glassware, for which respondents' budgets averaged \$4,000 and \$2,200, respectively.

### Share of Budget by Consumables Product Type, 2011

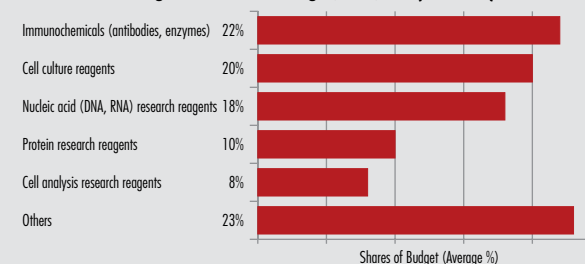
#### Chemicals Budget, \$48,100 (N=140)



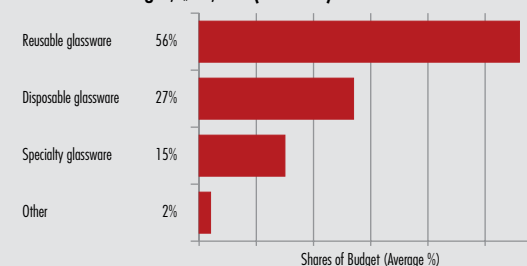
#### Plasticware Budget, \$18,500 (N=136)



### Life Science Reagents and Kits Budget, \$48,700 (N=103)



### Glassware Budget, \$14,900 (N=133)



Large capital expenses, including instrument and equipment purchases, were drastically cut in 2009. Budgets for these high-value items were often the first to be cut, frozen, or eliminated. As a result, the economic downturn had a far greater impact on instrument and equipment budgets than on any other laboratory product. After over a year of being forced to make do with obsolete technologies, a large number of laboratories eagerly made purchases in 2010 with reinvigorated instrument and equipment budgets. While 2011 increases were not as high as 2010 increases, respondents reported that both instrument and equipment budgets went up by 4.1% last year. Respondents also plan for instrument and equipment budgets to go up again in 2012—by 5.4% and 3.4%, respectively.

In 2011, respondents set aside an average of \$12,300 for the purchase of chromatographers, which was the single greatest instru-

ment investment. Following chromatographers, the next greatest instrument expenses include \$9,000 for microscopy systems, \$7,400 for spectrophotometers, and \$7,400 for balances. Respondents' instrument purchases were very fragmented: an average of \$28,700 was budgeted for instruments other than those mentioned. Refrigerators and freezers are respondents' leading equipment expenditure, with an average of \$6,000 reserved for their purchase. Respondents budget between \$2,000 and \$3,000 for other pieces of equipment, such as water systems, ovens, pumps, baths, hot plates, and evaporators.

Laboratories are usually self-sufficient when it comes to the maintenance of their instruments and equipment. When asked who is responsible for providing service and repair, respondents regularly selected "Myself/My department"—56% for the service of their instruments and 57% for the service of their equipment. Respondents more heavily rely on their manufacturer service contract for the service and repair of their instruments; 59% of respondents use an instrument manufacturer service contract compared to only 30% of respondents who use an equipment manufacturer service contract. Instead of relying on their manufacturer, 41% of respondents depend on their in-house service department for the service and repair of their equipment, whereas only 34% of respondents depend on in-house service for their instruments.

### Outlook for 2012 and 2013

For the most part, laboratories should expect to see their budgets remain flat in 2012 and the outlook for



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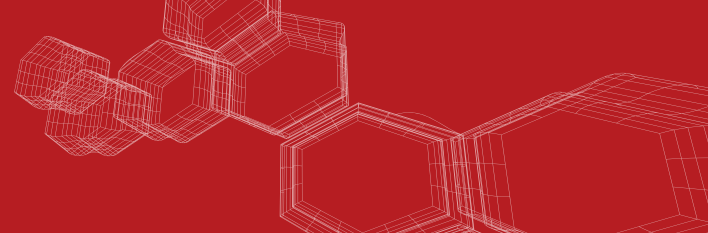
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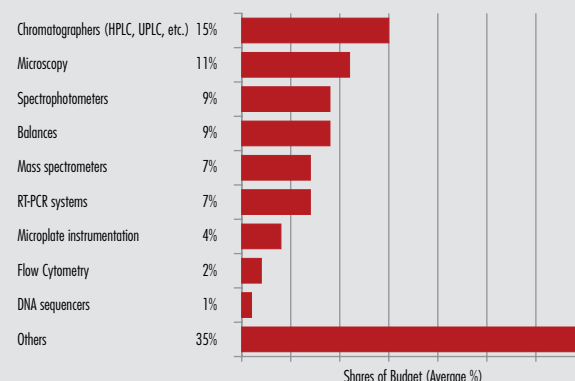




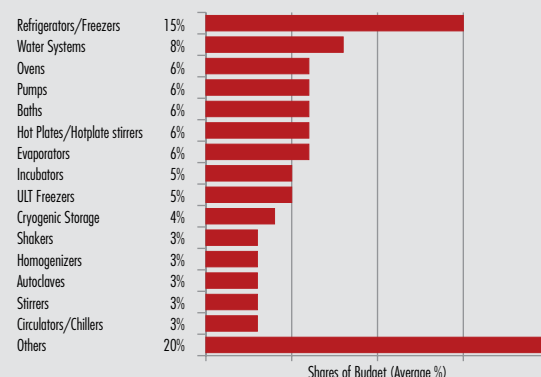
### Share of Budget by Instrument and Equipment Product Types, 2011

Source: Frost &amp; Sullivan analysis.

#### Instruments Budget, \$82,100 (N=145)



#### Equipment Budget, \$40,600 (N=143)



2013 is not much better. A United States Senate panel approved a 2012 spending bill that would trim the National Institutes of Health (NIH) budget by 0.6%, or \$190 million. Moreover, the White House Office of Management and Budget (OMB) is asking federal departments and agencies to plan for 2013 budgets that are 5% and 10% below 2011 discretionary spending levels. Given recent austerity measures and the continued economic slowdown, funding for research and development in Europe and Japan is likely to be trimmed by similar amounts. Consequently, laboratories that depend on government funding will have to find ways to further slash their budgets.

The two-year outlook for private-sector research and development laboratories is not as bleak: global biopharmaceutical revenues continue to grow at rates of 5% and higher. Similarly, contract research organizations (CROs)

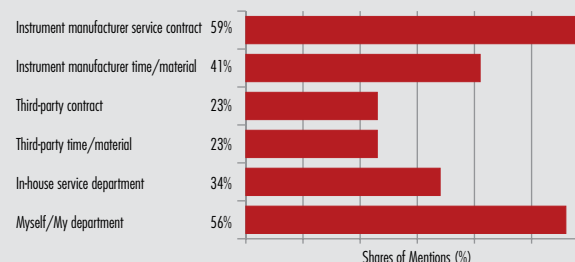
biotechnology companies, and CROs. Private-sector laboratories outside the life sciences also can expect some growth in their budgets. For example, as petroleum costs steadily increase at around 6% annually, the laboratories that support the petrochemical and chemical industries can expect similar budgetary increases.

As survey respondents point out, the leading events and factors that influence laboratory spending are the endless call for new projects and technological advances. The mix in spending between various product categories will continue to fluctuate given the cyclical stocking of laboratory inventories combined with the replacement of instruments and equipment. Overall, the decline in government funding and the modest growth in private-sector funding should offset each other, resulting in an average laboratory budget that grows no more than 2% in 2012 and 2013.

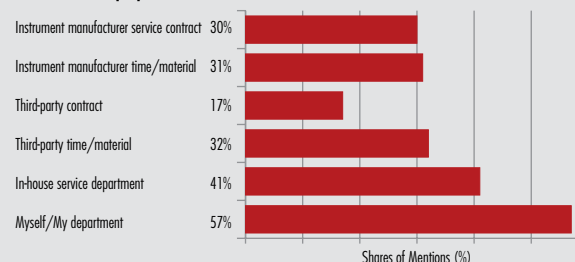
### Services Used for Repair of Instruments and Equipment (N=146)

Source: Frost &amp; Sullivan analysis.

#### Service of Instruments



#### Service of Equipment



expect their compound annual growth rate to exceed 8% between now and 2017. These indicators bode well for the laboratories that support pharmaceutical companies,

**Jonathan Witonsky**, Industry Manager, Life Science Research Tools & In Vitro Diagnostics, Frost & Sullivan, can be reached at [jonathan.witonsky@frost.com](mailto:jonathan.witonsky@frost.com), or by phone at 650-475-4520.

## EASILY IDENTIFYING METALS WITH THE POWER OF HEAT

Atomic absorption (AA) has been known since the 19th century, but it was not until the 1950s, thanks to efforts by Alan Walsh at Australia's CSIRO research center, that use of AA spectrometers became routine for metals analysis.

AA measures ultraviolet light absorbed by hot, atomized metals. The absorbance wavelength is unique to every metal, but the signal intensity varies by concentration. Instrumentation is straightforward, consist-

ing of a light source, atomizer and detector. Atomizers are traditionally high-temperature flames, but graphite furnaces and various plasma sources are also used. Light sources include hollow cathode lamps (most common) and diode lasers. Detectors are most usually photomultiplier tubes. AA could be considered for nearly any application that requires the identification and/or quantification of metals, including environmental analysis, forensics, archeology, mining, agriculture and quality control for contaminant, ingredient, or trace metal in foods, drugs, personal care products, paper, materials, and other products.

Chuck Schneider, business unit manager for PerkinElmer's (Shelton, Conn.) inorganic analysis products, breaks AA instrumentation down into three categories: flame, graphite furnace, and dedicated analyzers. PerkinElmer further delineates these into entry-level systems and higher-end systems with more extensive automation, software, data handling, and the ability to switch back and forth from flame to graphite furnace operation.

**“AA has got to be dead simple to use, because instruments are used by a lot of different people who may not have specific training in the technique,” says Chuck Schneider of PerkinElmer.**

With more or less the same hardware technology accessible to all manufacturers, Yong Xie, AA product manager at Aurora Biomed (Vancouver, BC), believes that some vendors err in focusing on the hardware and automation alone and not enough on the ease of use—a factor noted in the PerkinElmer study. “The computer industry has made huge progress in both hardware and software,” he says, as have advances in automation, autosampling, and unattended operation. Since these advances won't help with detection limits or other fundamental performance factors, “they are best applied to enhancing the user experience, to provide the most convenient environment for operating the instrument and achieving desired objectives.”

PerkinElmer has recently completed a large survey of inorganic analysis customers and found that the top two factors entering into purchase decisions are customer service (including the salesperson's knowledge and service support)

and ease of use and setup for hardware and software. The third factor is the vendor's reputation. Price is “fifth or sixth on the list,” Mr. Schneider says. “AA has got to be dead simple to use, because instruments are used by a lot of different people who may not have specific training in the technique. Years ago a lab might have had five people operating six or seven instruments. The number of techniques has remained the same, but the number of analysts might be down to two. Lab workers need to be generalists.”

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TRADITIONAL USES GIVING WAY TO PORTABILITY

Although serious Fourier-transform infrared spectroscopy (FTIR) research and core analysis facilities are still doing well, traditional applications are giving way to more dynamic uses such as controlling processes and field work.

For research FTIR, where polymer, materials, coatings, and industrial applications still predominate, the new kid on the block is cell and tissue analysis. Modern biology relies heavily on fluorescently labeled dyes that identify cells' surface markers and internal workings. Cells are then isolated and characterized by cell sorters according to which labels light up. Tissues are similarly analyzed by fluorescence microscopy.

But microscope-based imaging FTIR is making inroads into cell biology in ways that were barely imagined just a few years ago, says Keith Bratchford, marketing director at Agilent Technologies' Melbourne, Australia, facility.

Using this technique, scientists can create multidimensional maps of a tissue based on its chemical composition. The technique has numerous applications in diagnosing abnormal cells and tissues in a variety of diseases, including cancer, Alzheimer's disease, and Parkinson's disease. The enabling technology behind this is the focal plane array detector, which rapidly provides a full spectrum for every pixel within the microscope field in a matter of seconds. Performing the same analysis with single-point

detectors could take many hours or days without providing the same level of resolution.

"Focal plane arrays acquire all spectra at once, the same as taking a photograph with a CCD-based camera. The arrays capture sig-

bilities and may not have the same level of expertise with any one of them as their predecessors.

Related is the issue of transportability. No, we're not talking handheld FTIR, but rather instruments that may be moved from one loca-

**"A key trend in FTIR instrumentation, according to Sharon Palmer, materials characterization business manager at PerkinElmer (Bucks, UK), is the 'deskilling' of the user base."**

nificant areas of the sample in one shot," says Mr. Bratchford. "But you need a lot of very high level processing to handle the data."

When fully developed, FTIR microscopy will have numerous applications in food safety and pathogen detection. Agilent is working with Montreal's McGill University on techniques to identify bacteria rapidly. One day, spectral libraries of viruses, bacteria, and fungi will allow rapid screening of medical, pharmaceutical, and food products for pathogens.

A key trend in FTIR instrumentation, according to Sharon Palmer, materials characterization business manager at PerkinElmer (Bucks, UK), is the "deskilling" of the user base. Many labs, she says, used to maintain dedicated FTIR resources that included laboratory-trained, degreed scientists. Now instrument operators have multiple responsi-

tion within the facility to another.

PerkinElmer has also long been a proponent of simplifying software. FTIR products are controlled through an application iPhone users would appreciate. Users are provided with a very limited number of choices on each screen but, at the same time, may access detailed guidance and instructions.

Ms. Palmer sees FTIR becoming more useful in screening applications due to its simplicity and the growing need to obtain answers quickly. In addition to microbiology applications, she anticipates methods for screening food and pharmaceutical ingredients, adulterated fuels, raw materials, and counterfeit drugs. "There are many potential opportunities where FTIR offers one or more pieces in the puzzle."



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Exoscan Handheld FTIR

- Spherical ATR Sampling interface permits analysis of powders and granules, as well as polymer, composite and plastic sheets
- Features a frequency range of 4000 – 650 cm-1 and maximum resolution of 4 cm-1
- Incorporates a commercial PDA that controls operator functions and presents results of sample analysis



Agilent [www.agilent.com](http://www.agilent.com)

Driver for Analect FTIR Spectrometers SII-AN03

- Integrates the functions of Analect instruments into Symbion-DX and RX software suites
- Each method is permanently stored in Symbion database and is under full version control, compliant with 21 CFR Part 11
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Symbion Systems [www.gosymbion.com](http://www.gosymbion.com)

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FTIR SPECTROPHOTOMETER MANUFACTURERS

Agilent	<a href="http://www.agilent.com">www.agilent.com</a>
ABB	<a href="http://www.abb.com">www.abb.com</a>
Bruker Optics	<a href="http://www.brukeroptics.com">www.brukeroptics.com</a>
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Newport Corporation	<a href="http://www.newport.com">www.newport.com</a>
PerkinElmer	<a href="http://www.perkinelmer.com">www.perkinelmer.com</a>
Shimadzu Scientific Instruments	<a href="http://www.ssi.shimadzu.com">www.ssi.shimadzu.com</a>
Symbion Systems	<a href="http://www.symbion.com">www.symbion.com</a>
Thermo Scientific	<a href="http://www.thermoscientific.com">www.thermoscientific.com</a>

GROWING IN SENSITIVITY

GC was once commonly called “GLC,” where the “L” stands for liquid. Inside GC columns are particles of a ceramic or inert material coated with a viscous liquid stationary phase that interacts with the analyte. By contrast, HPLC stationary phases are bonded to the base material. New GCs are sold with software that integrates peaks, stores methods, assists in report writing, and controls instrument functions.

GC detectors have been evolving rapidly to provide greater sensitivity. Flame ionization detectors (FIDs) have been the most widely used, as they detect any molecule containing carbon. Numerous other detector types have been introduced over the years, but the most interesting is the mass detector, which is essentially a miniaturized mass spectrometer. Mass detectors provide unequivocal identification of peaks emerging from the chromatograph based on the molecules’ molecular weights and fragmentation patterns.

High-throughput analysis was once associated with commercial labs, but today even academic groups value productivity, says Jim Edwards, business development manager at Thermo Fisher Scientific (Austin, TX). Instruments that perform faster separations are available, but this has introduced a detection bottleneck. “Vendors who place a premium on accelerating chromatography should similarly speed up detection to acquire data at a speed appropriate to good precision and perfor-

mance.” Less easily achieved is the design of instruments that do not suffer from “fatigue effects,” that is, show signs of slowing down or require maintenance after one or two thousand cycles. Maintenance downtime, Edwards observes, is a productivity killer that easily negates the benefits of more rapid analysis or cycling.

GC systems have become faster and more selective to the point where analysts now look to dead times during analytical runs to eliminate inefficiencies. Alessandro Baldi, business manager for chromatography software at

load and unload the sample,” Baldi says. In an optimal configuration, the autosampler engages not at the precise moment it is needed, but when the oven is almost at the right temperature.

A third approach is to integrate the GC with sample prep devices to provide greater flexibility and less of a hardwired configuration. PerkinElmer has recently collaborated with Tekmar (Mason, OH) on purge-and-trap sample concentration and with CTC (Zwingen, Switzerland) on solid-phase micro-extraction. Baldi says the goal is to minimize sample preparation.

“GC systems have become faster and more selective to the point where analysts now look to dead times during analytical runs to eliminate inefficiencies.”

PerkinElmer (Waltham, MA), says this is best achieved by avoiding changes that will disrupt work-flows or force analysts to alter established methods.

Oven equilibration is one obvious bottleneck. PerkinElmer tackled equilibration by designing an oven with very low mass that cools down rapidly by fast-moving, non-recirculated air.

Next, the company went after autosampling by implementing lookahead functions. “It takes time to inject, clean the needle, and

Reductions in per-injection cycle times may be achieved through the use of flow-splitting techniques that divert eluent to multiple columns or post column to one of several detectors. Splitting allows analysts to switch columns or detectors on the fly without having to turn off the instrument, allow components to cool down, and swap them out. In essence, splitting creates “multiple” chromatographs from one instrument.

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- Engineered to deliver lab-quality GC performance in the field, on the production line, or wherever you need fast accurate GC measurements
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GC312

- Features flame ionization and flame photometric detectors with flame out sensors that shut off the hydrogen if the flame goes out
- Includes a 7-inch color touch screen
- Low and high set-points (depends on the options) can be customer-programmed for each point and/or compound



PID Analyzers [www.hnu.com](http://www.hnu.com)

Forston Mini GC

- Based on Seacoast's sensing and sampling technology and is integrated with the Forston Labs LabNavigator
- Provides real-time data on-site, or can send data to supervising chemist via cell phone
- Has the ability to acquire, monitor and analyze data from up to 5 simultaneous sensor inputs
- Suitable for various applications, such as soil and water remediation, security and safety, industrial processing and quality control



Seacoast Science [www.seacoastscience.com](http://www.seacoastscience.com)  
Forston Labs [www.forstonlabs.com](http://www.forstonlabs.com)

GC SYSTEM MANUFACTURERS

Agilent	<a href="http://www.agilent.com">www.agilent.com</a>
Buck Scientific	<a href="http://www.bucksci.com">www.bucksci.com</a>
CDS Analytical	<a href="http://www.cdsanalytical.com">www.cdsanalytical.com</a>
Forston Labs	<a href="http://www.forstonlabs.com">www.forstonlabs.com</a>
GOW-MAC	<a href="http://www.gow-mac.com">www.gow-mac.com</a>
Inrag	<a href="http://www.inrag.ch">www.inrag.ch</a>
LECO	<a href="http://www.leco.com">www.leco.com</a>
OI Analytical	<a href="http://www.oico.com">www.oico.com</a>
PAC	<a href="http://www.paclp.com">www.paclp.com</a>

Parker Balston	<a href="http://www.labgasgenerators.com">www.labgasgenerators.com</a>
PerkinElmer	<a href="http://www.perkinelmer.com">www.perkinelmer.com</a>
PID Analyzers	<a href="http://www.hnu.com">www.hnu.com</a>
Quadrex Corp.	<a href="http://www.quadrexcorp.com">www.quadrexcorp.com</a>
Shimadzu Scientific Instruments	<a href="http://www.ssi.shimadzu.com">www.ssi.shimadzu.com</a>
Teledyne Tekmar	<a href="http://www.teledynetekmar.com">www.teledynetekmar.com</a>
Thermo Fisher Scientific	<a href="http://www.thermoscientific.com">www.thermoscientific.com</a>
Waters	<a href="http://www.waters.com">www.waters.com</a>
Zoex	<a href="http://www.zoex.com">www.zoex.com</a>

Buck Scientific Chromatography Systems



Whether you are looking for an HPLC or a GC, Buck can design a custom system for your application that will be easy to use, and give you maximum ROI through low cost of ownership. Our Gas Chromatographs can accommodate 6 Detectors from a choice of 9 and 4 injectors from a choice of 6. From our simple fixed wavelength HPLC to our fully automated High Pressure Gradient Semi Preparative HPLC, Buck Scientific offers a wide variety of High Performance Liquid Chromatographs. Our HPLC systems are modular, upgradeable, and easily maintained. Our affordable instruments, spares & accessories makes our HPLC systems more cost effective than any other system on the market.





# ADDING A SECOND DIMENSION TO GC

Gas chromatography-mass spectrometry (GC-MS) is the fastest-growing GC method. Mass detection, which can take a variety of forms based on the MS component, provides a dimension that conventional thermal conductivity or flame ionization detectors cannot, namely selectivity and absolute identification of both known and unknown compounds.

GC-MS is suited to every organic chemical discipline where GC is found, including the chemical, pharmaceutical, environmental, and forensics industries, as well as basic research. But the limitations of GC-MS are the same as for GC alone: compounds must be volatilized and relatively nonpolar; molecular weights are therefore limited to about 800 Dalton.

GC-MS identifies compounds based on matching a mass spectrum from a run with entries in a database or spectral library generated with the same MS technique (hardware, ionization, detection).

Whereas co-elution is common in GC, MS distinguishes closely related compounds, for example, structural isomers, on the basis of their fragmentation patterns. And while MS cannot tell mirror-image enantiomers and most diastereomers apart, GC columns can—in the case of enantiomers, with a chiral stationary phase. This is one reason why GC and MS are considered complementary techniques, and why their combination is so powerful.

Environmental Protection Agency and U.S. Pharmacopoeia GC

methods are bedrock techniques used and referred to for environmental and pharmaceutical analysis, respectively. These methods have benefitted tremendously from the adoption of mass detection, notes Trisa Robarge, GC and GC-MS product manager at Thermo Fisher Scientific (Austin, TX). “As regulations for both industries evolve toward lower detection limits and higher specificity, analysts have benefitted particularly from triple-quad MS, which facilitates analysis of low-level compounds from complex samples.”

**“Despite the appeal of GC-MS and the broad range of cost and capability available, not every method demands its sensitivity and selectivity.”**

Software and information technology supporting GC-MS have also greatly improved, Robarge says. Many systems today are supported by compound libraries and integrate with laboratory information management systems and/or electronic notebooks that allow archiving, managing, and sharing of analytical data.

A typical entry-level GC-MS system would likely incorporate a single-quadrupole (“quad”) detector or a more sophisticated ion trap, which allows extensive analysis of fragments and fragments of fragments—“MS/MS” experiments. Also popular are time-of-flight (TOF) instruments.

These detectors suffice for most applications but their resolution is only about one atomic mass unit. To analyze isotope ratios, one would turn to either a triple-quad or magnetic-sector MS detector. “But as selectivity goes up so does your investment,” Robarge tells *Lab Manager Magazine*.

Despite the appeal of GC-MS and the broad range of cost and capability available, not every method demands its sensitivity and selectivity. Flame ionization is perfectly suited to quantifying blood-alcohol levels or analyzing low-molecular-weight hy-

drocarbons in the oil and gas industry, and electron capture is routinely used to screen pesticides in foods.

Mark Taylor, GC and GC-MS product manager at Shimadzu Scientific Instruments (Columbia, MD), notes that GC, particularly GC-MS, has been losing market share to liquid chromatography-mass spectrometry (LC-MS). “GC-MS was the flagship analysis tool for organic compounds for many years. But when ionization issues were overcome with LC-MS, users realized that LC was easier to operate and required less sample preparation than GC-MS.”

## RECENTLY RELEASED GC-MS SYSTEM

### SCION SQ™ and SCION TQ™

- Simple to use, incredibly sensitive, and deliver robust and reliable performance
- Comes complete in a space-saving package that makes upgrading a simple and cost effective process
- Come with an MRM Method Builder—designed by chromatographers
- Include a factory-installed compound library that contains over 2500 MRM transitions



Bruker

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### GCMS-QP2010 SE

- Enhanced maximum column flow up to 4 mL/minute gives users the ability to select from a variety of columns so that productivity and sample throughput can be dramatically increased.
- Optional direct injection probe lets users easily obtain a mass spectrum when analyzing materials that don't lend themselves to chromatography
- Front-opening chamber means maintenance can be performed with ease



Shimadzu

[www.ssi.shimadzu.com](http://www.ssi.shimadzu.com)

### Clarus SQ 8

- Delivers excellent throughput and productivity by minimizing requirements for calibration of instruments and reducing the need for sample preparation and concentration
- Includes the patented GC oven, which has the fastest heat-up and cool-down times for shorter injection-to-injection and analytical cycle times
- Has an 800:1 signal to noise specification and reduces background noise



PerkinElmer

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### TSQ Quantum XLS

- Features proprietary DuraBrite IRIS ion source, for high sensitivity in the low femtogram range
- Combines full scan MS analyses of metabolites and targeted analysis
- Features the ability to change from EI to CI without venting the system
- Includes a zero cross-talk angled collision cell to eliminate false positives



Thermo Fisher Scientific

[www.thermo.com](http://www.thermo.com)

## GC-MS SYSTEM MANUFACTURERS

Agilent	<a href="http://www.agilent.com">www.agilent.com</a>
Bruker	<a href="http://www.bruker.com">www.bruker.com</a>
LECO	<a href="http://www.leco.com">www.leco.com</a>
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# SPARING ANALYSTS FROM BORING, REPETITIVE WORK

Chromatographers who learned their craft twenty years ago may not have been familiar with autosamplers then, but today nearly every high performance liquid chromatography (HPLC) instrument includes an autosampler as standard equipment.

“Autosamplers existed in the early days of HPLC but many scientists preferred manual injection,” notes Simon Robinson, HPLC product manager at Shimadzu Scientific Instruments (Columbia, MD). When sample was plentiful, manual injection was a convenient way to flush the injection loop between runs, an operation most easily accomplished (at the time) by hand.

But the main reason most lab workers preferred manual injection was that early autosamplers were not very reliable. Robinson recalls horror stories where analysts set up a tray of twenty labile samples or so, then returned the next day to find the instrument stuck on sample number two and all the remaining samples “wrecked.” However, “There’s been so much engineering focused on improving these instruments that it’s safe to say autosamplers are 100 percent reliable,” Robinson adds.

Autosamplers spare lab analysts from uninteresting, repetitive work. Even more time is saved when they are coupled with robotic sample preparation. Their major contribu-

tions to HPLC are reproducibility, repeatability, precision, and accuracy in delivering precise injection volumes.

So who would not routinely use an autosampler? According to Robinson, academic labs still rely heavily on manual sampling and injection because their primary objective, aside from data quality, is cost-effectiveness.

Another area where autosamplers are often impractical, observes Helmut Schulenberg-Schell, Ph.D., worldwide LC marketing manager

analytical laboratories, and autosamplers play prominently among the various “fast” techniques adopted toward achieving those goals. Autosamplers have become critical enablers—like columns, pumps, and detectors—of these trends, and in doing their part they have required substantial re-engineering for both stand-alone performance and integration. As such, autosamplers have been a primary target of engineering efforts to shorten cycle times

vs. simply run times. After all, an HPLC or UPLC system does not add much in the way of throughput or speed in reducing analysis time if the slowest link in the cycle still requires

several minutes to re-equilibrate.

The wider adoption of UHPLC underscores the “need for speed” and the role of autosamplers within that scheme. “Now, suddenly,” says Schulenberg-Schell, “you can run ten times as many samples on an HPLC instrument, and the question of automation in sampling, injection, sample prep, and sample tracking becomes more urgent.”

**“Autosamplers have been a primary target of engineering efforts to shorten cycle times vs. simply run times.”**

for Agilent Technologies (Waldbronn, Germany), is in preparative HPLC. Prep work tends to be specialized, one-off, non-routine, and does not require the sensitivity or accuracy of analytical HPLC.

Autosamplers provide a level of automation, throughput, and productivity that is multiplicative. Using an autosampler, one chromatographer can operate multiple HPLC systems simultaneously, injecting many hundreds of samples after spending just a few minutes with the control software. This frees workers to perform other tasks like making mobile phases or analyzing data.

Speed, throughput, and reduced sample volumes are critical for most

## RECENTLY RELEASED HPLC AUTOSAMPLERS

### 1290 Infinity LC System

- Features the first high-throughput sample injection modules to provide 1290 Infinity LC pressure capability at 1200 bar
- Extends sample capacity to 24 cooled microwell plates or 648 cooled 2-mL vials
- Allows for ultra-fast injection times of less than 5 seconds without compromising carryover

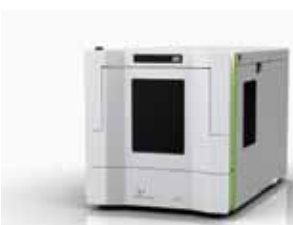


Agilent

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### Flexar

- Injects sample volumes as little as 1 µL at pressures up to 15,000 psi with the FX UHPLC autosampler
- Loads sample in only 8 seconds (in partial fill mode)
- Three injection modes: full loop, partial fill and µL-pickup with no sample waste
- Peltier cooling/heating mode option for operation at 4°C to 40°C. Will reach with 4°C ± 2°C achievable even at ambient temperatures up to 25°C



PerkinElmer

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### Model 758 Liquid Autosampler

- Provides all the essential automated sample analysis capabilities, such as bubble elimination, syringe washes, and controlled injection speed for a wide variety of viscosities
- Available in 100V, 115V, and 230V configurations and contains a 110-position tray
- Syringe holder can support 10, 25, or 100 µL syringe sizes

PAC

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### UHPLC-SA LC Set

- Offers extended features and enhanced UHPLC performance for the compact, stackable Alias™ autosampler and SPH1240 pumpset
- Alias autosampler provides an injection volume from 1 to 10000 µL
- The autosampler’s efficient, multi-solvent needle wash virtually eliminates carry-over
- Handles two high or low well plates or 48 (2 x 48) sample vials



Spark Holland

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## HPLC AUTOSAMPLER MANUFACTURERS

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PerkinElmer	<a href="http://www.perkinelmer.com">www.perkinelmer.com</a>
Spark Holland Inc.	<a href="http://www.sparkholland.com">www.sparkholland.com</a>



# WHERE THE ACTION IS

Now that sub-2-micron columns have become the stationary phase technology of choice for research labs and have made substantial inroads in quality, food, and pharmaceutical settings, another breakthrough in column technology looms. Superficially porous particles (SPPs), also known as fused-core, shell, porous-shell, and Poroshell (Agilent's trademark) particles, have been around since the 1960s. SPPs were used extensively until the 1980s, when fully porous particles began their long domination.

SPPs employ a porous "shell" of silica wrapped around a solid silica core. Molecules diffuse into and out of the particles much more rapidly and efficiently than through fully porous media, which results in faster, sharper separations.

Most vendors claim that SPPs result in separations that are close, and in some cases superior, to those of UHPLC, but at back pressures typical of conventional LC.

Jason Link, Ph.D., LC columns product manager at Agilent (Wilmington, DE), believes that SPPs have revitalized HPLC for aging instruments.

"Users with older chromatographs, or that are cash-crunched, can now get many of the benefits of UHPLC without having to purchase a new instrument."

Dr. Link estimates that SPPs provide "80 to 90 percent of the

efficiency of sub-2-micron columns, at 40 to 50 percent of the back pressure." The performance boost, he says, results from improved mass transfer and the greater particle size uniformity.

Most SPPs are in the high-2-micron size range. Phenomenex (Torrance, CA) has recently introduced a sub-2-micron porous shell particle that combines the advantages of very small particles and SPP technology. These 1.7-micron SPPs are solvent-sparing, as one would expect, and result in back pressures comparable to those of UHPLC, about 1,000 bar.

Dafydd Milton, Ph.D., product manager for LC and LC/MS columns at Thermo Fisher Scientific (Runcorn, UK), says trends in column technology are all about increasing speed.

**"Most vendors claim that SPPs result in separations that are close, and in some cases superior, to those of UHPLC, but at back pressures typical of conventional LC."**

High-temperature operation is an often overlooked approach to fast LC without encountering back-pressure woes. As temperature rises, solvent viscosity decreases, mass transfer increases, and analyte partitioning into the stationary phase is

enhanced, resulting in shorter runs and sharper peaks.

Most stationary phases fall apart at a temperature approaching 250°C, and systems are generally not equipped for heating. "Conventional C18 bonded phases are simply not stable at high temperatures," Dr. Milton says.

Users considering high-temperature operation will need to invest in third-party column ovens and systems for preheating the mobile phase. They will also require rugged columns.

Novel column technologies such as SPPs, hydrophilic interaction chromatography (HILIC), and monoliths provide more options, but they also resurrect sticky questions about method transfer. Labs that submit instrument results to legal and regulatory authorities live by

standardized, validated methods, as do QC and other high-volume functions. And while some complaints are no doubt exaggerated, organizations can rarely justify revalidating all their analytic methods.

There is no simple answer, as labs must justify everything

economically. Solvent savings and higher throughput alone might justify method transfer for a large pharmaceutical organization, but not perhaps for a forensics or environmental laboratory that makes 20 or 30 injections per week.

## RECENTLY RELEASED HPLC COLUMNS

### ZORBAX UHPLC RRHD 300SB-C18 1.8 µm columns

- Provide stability at low pH and symmetrical peaks for protein and peptide separations with trifluoroacetic acid or formic acid mobile phase modifiers
- Increased efficiency for improved resolution and more robust quantitation of post translational modifications
- Bring UHPLC performance to protein analysis with pressure stability to 1200 bar



Agilent

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### Kinetex® XB-C18 and C8

- Offer advantages of UHPLC within standard HPLC operating pressures
- XB-C18 incorporates two iso-butyl side chains at the base of the C18 ligand for reduced secondary interactions with residual silanols
- C8 meets United States pharmacopeia (USP) specifications for classification code I7



Phenomenex

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### Accucore™

- Provide a unique chromatography solution to enhance laboratory workflow and efficiency
- Available in a wide range of stationary phase selectivities and compatible with almost any instrument, these columns give increased sensitivity and peak resolution
- Allow high-speed, high-resolution separation, with backpressures significantly lower than those columns associated with UHPLC



Thermo Fisher Scientific

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### XSelect

- HSS Cyano and HSS PFP columns offer scientists an alternative to traditional C18 column chemistries
- Give scientists more control over the resolving power of their HPLC separations
- Reduce time and method development costs



Waters

[www.waters.com](http://www.waters.com)

## HPLC COLUMN MANUFACTURERS

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[www.ace-hplc.com](http://www.ace-hplc.com)

### Agela Technologies

[www.agela.com](http://www.agela.com)

### Agilent

[www.home.agilent.com](http://www.home.agilent.com)

### Applied Biosystems

[www.appliedbiosystems.com](http://www.appliedbiosystems.com)

### Beckman Coulter

[www.beckmancoulter.com](http://www.beckmancoulter.com)

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[www.chiraltch.com](http://www.chiraltch.com)

### Dionex

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### Dynamax

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### Eksigent

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### ES Industries

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### Grace Davison Discovery Systems

[www.discoverysciences.com](http://www.discoverysciences.com)

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### SigmaAldrich

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### SiliCycle Inc.

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### Supelco

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### Tosoh Bioscience

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### Valco

[www.vici.com](http://www.vici.com)

### Waters

[www.waters.com](http://www.waters.com)

### Whatman

[www.whatman.com](http://www.whatman.com)

### Zirchrom

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# CRITICAL FIRST STEPS IN LC ANALYSIS

As HPLC systems become faster and employ increasingly exotic stationary phases, sample preparation becomes essential for reliable, reproducible analyses.

Biological samples generally require concentration in the target analyte and, in the case of proteins, depletion of high-concentration interfering materials. Sample concentration may be carried out through dialysis or with specialized evaporation systems. Porvair Sciences (Leatherhead, UK) and other vendors sell devices that blow heated nitrogen into individual microwells to speed evaporation and sample concentration. Depletion is somewhat harder to achieve, particularly when purifying a low-abundance protein in the presence of high-concentration species.

Depending on the sample type, common prep methods may include solid phase extraction (SPE), centrifugation, or liquid-liquid extraction. SPE is straightforward and available as single disposable cartridges filled by hand or through automated instruments. Protein prep for most LC-MS often involves an additional step, proteolysis, which breaks large molecules into smaller, more manageable peptides. Filtration is the simplest and perhaps most essential LC sample prep technique. Schleicher & Schuell MicroScience (S&S; Dassel, Germany) suggests filtering through a 0.45-micron microporous syringe membrane filter

to break up emulsions and retain particulates that clog columns.

S&S recommends regenerated cellulose (RC) membranes, which are hydrophilic, highly resistant to HPLC solvents, and show very low extractables. According to S&S, RC is one of the weakest protein binding membranes, which means it's suitable for proteomic analysis.

Sample preparation is an oft-overlooked source of error and inconsistency in HPLC analysis. Column and mobile phase conditions may be optimal and steady from run to run, but if samples are prepared differently, they will run differently as well.

That is why Simon Robinson, HPLC product manager at Shimadzu (Columbia, MD), recommends automating sample prep whenever possible. "Otherwise, reaching a point where data becomes untrustworthy is quite likely," he says. "Automated sample preparation eliminates human error."

One drawback of automated sample prep, however, is that standards and samples need to be refrigerated, which introduces scheduling issues and somewhat reduces the attractiveness of hands-off operation.

Paul Boguszewski, product manager for sample preparation products at Agilent (Santa Clara, CA), notes that automated sample preparation plays into three significant trends in LC analysis:

- Productivity (or lack thereof), speed of analysis, and throughput, as typi-

fied by fast, high-pressure systems (UPLC and fused core technology)

- Sensitivity at ever-lower analyte concentrations, which is the justification for adopting mass detectors (particularly triple-quad)
- Increasing complexity, particularly for biological samples

Agilent has constructed a matrix of preparation methods suitable for small-molecule HPLC analysis. Solid phase extraction is the most complete, versatile technique, removing particulates, proteins, lipids, oligomeric surfactants, and salts. At the other end of the efficiency scale, performing just a tad better than "dilute and shoot," is liquid extraction, which removes proteins only partially and not much else.

In between are dried matrix spotting, precipitation/filtration, and "smart" titration, which, successively, provide more efficient cleanup.

But as techniques become more efficient, they also raise the cost of sample preparation and complicate the workflow. Many lab managers view this as an absolute negative. This is a mistake, says Mr. Boguszewski, who claims the higher cost is illusory; cleaner samples translate to more robust, reproducible LC analysis, with fewer repeat runs.

## RECENTLY RELEASED HPLC SAMPLE PREP SYSTEMS

### SPE-DEX 4790® Solid Phase Extraction System

- Performs all solid phase extraction steps for aqueous samples directly from their original containers
- Handles 40 mL up to 20 L samples, accommodating SPE disks or cartridges
- Modularity allows for one to as many as eight extractors to be linked and controlled simultaneously
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### Strata™-X-Drug B Solid Phase Extraction (SPE) Sorbent

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- Does not require conditioning, saving time and solvent expense
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- Does not promote interconversion of norcodeine and normorphine to parent compounds

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### Perfinity Workstation

- Powered by Shimadzu hardware components that work in conjunction with five Perfinity optimized columns
- Can be used as a standalone unit for HPLC sample prep and also automates protein separations and mass spec sample preparation for more efficient LC-MS analysis
- Platform is customizable across application areas

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### Solid Phase Extraction (SPE) System MaxiLute™

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## HPLC SAMPLE PREP MANUFACTURERS

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Biotage	www.biotage.com
Gilson, Inc.	www.gilson.com
Horizon Technology	www.horizontech.com
Perfinity Biosciences	www.perfinity.com
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# POWERFUL NEW SYSTEMS, AND A RENAISSANCE FOR OLD SYSTEMS

Manufacturers of high-performance liquid chromatography (HPLC) systems continue to innovate, while simultaneously providing upgrade paths for older instruments.

Modular HPLC systems provide maximum flexibility and upgradability compared with “one box” integrated chromatographs. By switching modules, users can access the latest technology while reducing down-time during repair or servicing.

On the other hand, integrated systems are more affordable. Agilent's 1220 Infinity, which is modular, costs about 25 percent less than a comparably equipped 1260 model, yet the two use identical subcomponents. According to Dr. Michael Frank, marketing manager for analytical HPLC at Agilent (Waldbronn, Germany), integrated systems are less expensive because they use only one power supply, one set of communication electronics, and one cover.

Since HPLCs are long-lived instruments, upwards and downwards compatibility is a major concern. Compatibility also provides a relatively straightforward upgrade path, provided components are replaceable and the manufacturer has embraced open architecture. For example, older instruments may access quick-change valve technology, which facilitates plumbing tasks.

Method transfer has been the bane of chromatographers for years, and a major roadblock in the adoption

of novel HPLC technology. Many established methods specify not only solvents and gradients, but columns. As a result, many labs feel tied to old technology, however, users tend to exaggerate the cost and time involved in revalidating methods.

**“Since HPLCs are long-lived instruments, upwards and downwards compatibility is a major concern.”**

Regardless, a solution may be on the way. Agilent's Intelligent System Emulation Technology (ISET), available on its top-end HPLC systems, creates a software environment in which a chromatography run on, say, an Agilent 1290, can be made to emulate any older HPLC system and, according to Agilent, deliver “exactly the same results.” ISET is pure software and does not require hardware modifications.

In a company announcement at Pittcon, Agilent senior marketing director Stefan Schuette described ISET as “...the beginning of a new era” in which users “...will be free to develop, validate, and execute all methods on one single instrument... and to emulate those HPLC and UHPLC instruments to which a

method should be transferred or on which it has been developed.”

Dr. Frank believes legal and regulatory authorities will accept these “virtual” chromatography runs. “I’ve spoken with experts in regulated industries, and they don’t think it will be an issue.”

The advent of small-particle-size columns has made HPLC vendors rethink system design to exploit the new columns’ resolving power, says Alessandro Baldi, Ph.D., senior business director at PerkinElmer (Waltham, MA).

That means positioning the injector and gradient mix almost on-column, and the detector immediately outside at the back end. Proximity reduces volumes between modules and therefore helps eliminate dispersion while improving signal to noise and resolution. Perhaps the most exciting development affecting HPLC systems over the past several years has been the introduction of superficially porous silica particles.

The novel particles promise performance approximating—some vendors say exceeding—that of UHPLC but at normal back pressures, meaning labs can keep using their old HPLC equipment and achieve results normally associated with very high back pressures.

## RECENTLY RELEASED HPLC SYSTEMS

### SecurityGuard ULTRA UHPLC Column Protection System

- Suits almost any manufacturer's UHPLC, sub-2-micron or core-shell columns including the Phenomenex Kinetex® products
- Protects against the damaging effects of chemical contaminants and microparticulates introduced by the sample, mobile phase or system
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### Low-Pressure Gradient Unit for Nexera UHPLC

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- Facilitates dedicated separation of biomolecules, such as proteins and peptides, at ultra-high pressures
- Easy to use and can seamlessly integrate with the complete range of Thermo Scientific mass spectrometry (MS) systems for instant, trouble-free operation
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- Reduced system volume decreases dispersion
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## HPLC SYSTEM MANUFACTURERS

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Bio-Rad	www.bio-rad.com	PerkinElmer	www.perkinelmer.com
Buck Scientific	www.bucksci.com	Shimadzu	www.shimadzu.com
Cecil	www.cecilinstruments.com	SSI LabAlliance	www.laballiance.com
Dionex	www.dionex.com	Thermo Fisher	www.thermofisher.com
Eksigent	www.eksigent.com	TOSOH	www.tosoh.com
Gilson	www.gilson.com	Waters	www.waters.com
Hitachi	www.hitachi.ca		

# SOPHISTICATED METHOD FOR THE MASSES

Time-of-flight (TOF) mass spectrometry (MS) works by imparting equal energies to all fragments. Since smaller particles thereby travel faster, their masses are determined by how quickly they travel from the source to the detector.

TOF provides exquisite mass accuracy and resolution at very high dynamic range and response linearity within a spectrum. These qualities, says Alessandro Baldi, Ph.D., business manager for MS at PerkinElmer (Waltham, MA), allow analysts to focus on very specific mass ranges and eliminate signals outside that window. "That's why TOF shines for target characterization." TOF's other great benefit for this application is fast spectrum acquisition, up to 50 per second. Vendors will often couple instruments with software packages that supply results at a glance, which makes TOF a method of choice for rapid, routine screening for the presence or absence of particular masses in many samples.

Today's instruments, particularly MS/MS TOF mass spectrometers, are routinely used in proteomics, protein discovery, lipids, metabolomics, and drug and drug metabolite identification. Pharmaceutical companies, in particular, use these instruments to quantify and positively identify known and unknown compounds.

Another relevant TOF workflow is the identification of unknown com-

pounds in drug metabolism assays, drugs-of-abuse testing, foods and beverages, or environmental samples. Because of its highly discriminatory mass detection, TOF can distinguish, based on isotope ratios, whether a pharmaceutical was manufactured at an approved facility or by counterfeiters.

**"Specialists accustomed to room-size spectrometers of 20 years ago would marvel at how MS is now employed as a detector for liquid and gas chromatography."**

Accurate determination of isotope distributions also enables TOF instruments to distinguish between two compounds of equal molecular weight, providing unequivocal identification.

Ionization of MS samples is critical, since the instruments detect only ions. Numerous ionization techniques exist for solid and liquid samples prepared manually or obtained from the back end of a chromatograph. Most require exposing the sample to high temperature, radiation, or a stream of high-velocity gas. Direct analysis in real time (DART) directly ionizes samples, with no preparation, at atmospheric pressure and under gentle conditions. DART is suitable for the direct analysis of pharmaceuticals, chemicals, and even samples of dried blood, with no sample prep.

Diab Elmashni, senior marketing manager for LC and LC/MS at Thermo Fisher Scientific (San Jose,

CA), also notes that the current "big trend" in MS is more routine analysis.

Instruments have become easier to use in response. Specialists accustomed to room-size spectrometers of 20 years ago would marvel at how MS is now employed as a detector for liquid and gas chromatography. A

related capability is the rapid expansion of MS targets from smallish organic molecules to macromolecules.

The greatest strides in usability, says Mr. Elmashni, have been in software design. Software opens a mass spectrometer's full range of features to expert users while simplifying protocols for routine users through various levels of permissions. These allow the lab director or high-end operator to tweak the instrument as needed, or to write methods, while simplifying the interface for technicians through a nonalterable interface.

Similarly, software templates have simplified the process of running samples and analyzing data by taking over routine tasks such as data entry and report generation.

## RECENTLY RELEASED TOF MASS SPECTROMETERS

### BenchtoF-dx™

- Features capability to perform high-definition mass spectrometry (HDMS), a cost-effective technique for screening samples at trace levels
- Offers full-scan sensitivity at typical GC-quad SIM levels
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- Features fast acquisition rates, up to 1,000 spectra/s over the entire mass range
- Features a wide linear dynamic range (105)
- Generates constant ion abundance ratios across the chromatographic peak
- Supports several MS libraries, such as the NIST mass spectral library



DANI Instruments

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### Pegasus® GC-HRT

- Features proprietary Folded Flight Path™ (FFP™) technology to provide full-range mass spectra at speeds of up to 200 spectra per second
- Provides resolutions of up to 50,000 with high-performance mass accuracy
- KADAS® (Kinetic Algorithmic Data Acquisition System) provides high-integrity output under the most demanding acquisition conditions available



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### Xevo®G2 ToF

- Features UPLC®/MS and QuanTof™ technology for exact mass quantitative and qualitative performance
- UPLC/MS is a method of data acquisition that catalogs complex samples in a single analysis
- Can be upgraded to MS-MS capability using the same hardware



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## TOF MASS SPECTROMETER MANUFACTURERS

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[www.absciex.com](http://www.absciex.com)

ALMSCO International

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DANI Instruments

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# ILLUMINATING THE MICRO AND NANO WORLDS

Light microscopes, which view objects illuminated by visible light, have been around for centuries. Related are instruments that image nonvisible infrared or ultraviolet radiation, or ones that view fluorescence or Raman effects. All of these use optics to focus light into a viewing field, detector, or camera lens.

The technology behind visible light microscopes, arguably the oldest true laboratory instruments, has not changed much in fundamental operation in 200 years. Microscopes still consist of a light source, optics, and a stage for holding the specimen.

That does not mean that microscopy and microscopes are not evolving, says Lorne Davies, group manager at Olympus America (Center Valley, PA). He admits that innovation tends to be incremental rather than earthshaking, but each stage of improvement “enhances what users are looking for, which is crisp, high-quality images.”

For medical and diagnostic laboratory workers, a special focus of Olympus, the most critical improvement is ergonomics. Microscopists working in a cytology or pathology laboratory sit at their instruments for many hours at a time. Ergonomically friendly microscopes help users maintain comfortable body positions, minimize repetitive stress, and lessen fatigue on shoulders and eyes. Ease of use is another related feature in high demand.

One exciting development in light microscopy has been the widespread

adoption of fluorescence techniques. Fluorescence microscopy requires specialized reagents and equipment, including a camera to capture fleeting events. One fluorescence method, fluorescent in situ hybridization (FISH), enables investigators to identify and locate specific DNA sequences on chromosomes.

Another emerging technique is whole slide or “virtual” microscopy. This involves capturing microscope images and making them available on computer screens for later examination by one or more individuals. Virtual methods are useful for collaborative work, particularly in medical diagnostics.

What should potential buyers look for before purchasing a microscope? Mr. Davies puts a vendor’s reputation, service, and support high on the list. “People have close relationships with their microscopes, and that closeness extends to companies selling them.”

**“One exciting development in light microscopy has been the widespread adoption of fluorescence techniques.”**

This past year, Ravikiran Attota, Ph.D., a research engineer at NIST (Gaithersburg, MD), discovered a software technique that he claims provides the resolution of scanning electron microscopy (SEM) or atom-

ic force microscopy (AFM) through a conventional light microscope. The technique, through-focus scanning optical microscopy (TSOM), uses a software trick, and no additional hardware, to reconstruct images rapidly and at low cost.

In fact, Dr. Attota claims that his method improves on SEM and AFM in that it combines their strengths. SEM excels at lateral resolution, while AFM is best for vertical resolution, he says. TSOM achieves both through a paradoxical approach.

Optical microscopes cannot clearly visualize nanometer-scale features because the wavelength of visible light is larger than the object being imaged. Dr. Attota acquires many of these out-of-focus, or through-focus images anyway, at different focal points. The computer program he wrote combines the images and reassembles them into a TSOM image with spectacular depth capabilities. Where AFM provides depth resolu-

tion of only 1 micron, TSOM easily reaches 100 microns and in tests has produced images with 200-micron depth resolution.

## RECENTLY RELEASED MICROSCOPES

### Versa 3D DualBeam

- Provides high-resolution, three-dimensional (3D) imaging and analysis on a wide range of sample types
- Highly configurable platform allows customers to adapt the system’s capabilities to their specific requirements
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- Features high resolution imaging in TEM, STEM, and SE modes and ultrasensitive elemental mapping with a large angle Energy Dispersive Spectrometer (EDS)
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- Features a non-descanned detection scheme based on two highly sensitive GaAsP PMTS with equivalent collection efficiency
- Includes a motorized slider with 3 filter sets for flexibility in choice of dyes
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### Z850, 3035, and 3032PH Series

- Z850 Stereo Zoom Binocular and Trinocular Microscopes provide superior performance optics at an affordable price
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## MICROSCOPE MANUFACTURERS

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CRAIC Technologies [www.microspectra.com](http://www.microspectra.com)

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Hamamatsu [www.sales.hamamatsu.com](http://www.sales.hamamatsu.com)

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Leica Microsystems [www.leica.com](http://www.leica.com)

Meiji Techno America [www.meijitechno.com](http://www.meijitechno.com)

MilesCo Scientific [www.professionalmicroscopes.com](http://www.professionalmicroscopes.com)

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# PARTICLE CHARACTERIZATION: IT'S NOT ALL ABOUT SIZE

Although particle sizing is a mature technology, methods based on ultrasound and light scattering have been evolving slowly toward the characterization of ever-smaller particles, well into the nanometer size domain. Scanning electron microscopy (SEM) and transmission electron microscopy (TEM) remain the gold standards for both sizing and characterization, but these methods are too expensive for most labs and require highly-trained operators.

metrology as well as related environmental health issues. Instrument makers are focusing on higher resolution and throughput for particles below 100 nm in diameter. “Traditionally, this has only been possible using dynamic light scattering or electron microscopy,” says Matthew N. Rhyner, Ph.D., technical product manager at Beckman Coulter (Brea, CA). “But DLS is an inherently low-resolution technique because it is an ensemble method—it analyzes

equivalents” when analyzed by light scattering, depending on what part of the rod the laser “sees.” In contrast, a Coulter counter, which detects changes in electrical resistance, reports only volumes particles displace, so the readout will be monodisperse.

The method will not tell you if the particle is a sphere or a cylinder, however. That requires an imaging step.

Irregularly shaped but uniformly manufactured nanoparticles are increasingly important in optics, electronics, and consumer products. Quality control during their manufacture demands knowledge of their size or volume, and shape.

One reason is that nanoscale particles behave differently from macroscale materials. Physical forces or moisture can cause particles to clump. When analyzed by size alone, agglomerates will appear as larger particles. That may cause a batch of mineral or food additives to go back to the mill instead of to process development, where the real cause of the sizing issue needs to be addressed.

Similarly, a batch may appear perfect at the plant, but when it reaches a customer, sizing reveals it to be out of spec. Imaging is the most reliable way to determine if the material was milled incorrectly or if some other factor is at work.

a large number of particles at once, rather than individual particles.”

Emerging methods focus on discrete particle analysis, which affords much higher resolution and more detailed information on particle characteristics. These techniques rely on imaging technologies, which have progressed tremendously over the last two decades, thanks to advances in optics and digital photography. Imaging fills the huge gap between knowledge of a simple diameter or cross-section measurement and properties critical to a particle’s behavior.

Take an ensemble of rod-shaped particles, for example. The particles show up as a distribution of “sphere

“The approval of next-generation drugs will depend much on our ability to size and characterize nanoparticles.”

What’s more important is that SEM and TEM sample preparation is arduous and statistical significance is limited by the number of particles within the field that a user or camera can count. So while these methods are superb for analyzing a single or small number of particles, they don’t cut it in high-throughput industrial settings.

The ability to characterize ever-smaller particles is a direct response to discoveries in nanotechnology and nanomaterials, from which numerous products have arisen. The approval of next-generation drugs will depend much on our ability to size and characterize nanoparticles. Standards are beginning to emerge from ASTM and ISO on nanotech

## RECENTLY RELEASED PARTICLE SIZE ANALYZERS

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### Mastersizer 3000

- Features an extended dynamic range that spans 0.01 to 3500 microns
- Provides high performance with a small footprint
- Boasts well-engineered sample dispersion accessories, including an entirely novel dry powder dispersion unit
- Driven by friendly and intuitive software



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### SZ-100

- Analyzes key particle physical properties including size and zeta potential
- Capable of performing size measurements at both right angle and backscatter
- Allows particle size measurements with a variety of cells and sample volumes down to 10  $\mu\text{L}$
- Zeta potential cells can typically measure hundreds of samples before replacement



Horiba Scientific

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### Nanoparticle Characterization System NS200

- Features optimized locators, enabling the user to easily position the measurement cell
- An optional blue laser improves imaging capability; fluorescence filters can be added when working with suitably labeled particles
- Features an EMCCD (electron multiplying CCD) featuring 37 full frames per second



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## PARTICLE SIZE ANALYZER MANUFACTURERS

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Beckman Coulter	<a href="http://www.coultercounter.com">www.coultercounter.com</a>
Brookhaven Instruments	<a href="http://www.bic.com">www.bic.com</a>
CILAS Particle Size	<a href="http://www.particle-size.com">www.particle-size.com</a>
Clemex Technologies Inc.	<a href="http://www.clemex.com">www.clemex.com</a>
Dispersion Technology	<a href="http://www.dispersion.com">www.dispersion.com</a>
Fluid Imaging Technologies	<a href="http://www.fluidimaging.com">www.fluidimaging.com</a>
Formulation	<a href="http://www.formulation.com">www.formulation.com</a>
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Microtrac	<a href="http://www.microtrac.com">www.microtrac.com</a>
NanoSight	<a href="http://www.nanosight.com">www.nanosight.com</a>
New Star Environmental	<a href="http://www.newstarenvironmental.com">www.newstarenvironmental.com</a>
Particle Sizing Systems	<a href="http://www.pssnicomp.com">www.pssnicomp.com</a>
Shimadzu	<a href="http://www.ssi.shimadzu.com">www.ssi.shimadzu.com</a>
Sympatec	<a href="http://www.sympatec.com">www.sympatec.com</a>
TSI	<a href="http://www.tsi.com">www.tsi.com</a>



# OUT OF THE LAB, INTO THE FIELD

Raman spectroscopy has undergone a revolution during the last seven to 10 years, largely as a result of massive investment in the telecommunications industry. What were previously very large benchtop instruments requiring a Ph.D. operator, liquid nitrogen cooling, and price tags approaching \$500,000 have evolved into portable and even handheld instruments suitable for both laboratory and field operations.

“The catchphrase here is ‘out of the lab,’” says Eric Bergles, VP of sales and marketing at BaySpec (San Jose, CA). “And that

has been the key to applying Raman to new markets and applications, which are cropping up everywhere.”

Raman is effective for noncontact, nondestructive chemical analysis. Its attraction has been its applicability to many sample types with no preparation required.

One knock against Raman, however, is that many materials exhibit light-induced fluorescence when common Raman excitation wavelengths of 532 nm or 785 nm excitation wavelengths are used. Fluorescence interference may be tens or hundreds of times higher than the useful Raman signal.

But at longer-wavelength 1064 nm excitation, Raman overcomes interfering fluorescence, enabling the practical

application of Raman in situations where it could not previously be used.

Over the next decade, Mr. Bergles sees Raman moving into food inspection applications, among others. With up to 40 percent of our produce coming from overseas, monitoring fruits and vegetables for pesticide residues through traditional testing could hold up shipments for days or weeks. “With Raman, you

**“At longer-wavelength 1064 nm excitation, Raman overcomes interfering fluorescence, enabling the practical application of Raman in situations where it could not previously be used.”**

can do spot checks and know instantly if the produce is contaminated.”

Perhaps no industry has been as slow to take analysis “out of the lab” as highly protocol- and regulation-driven pharmaceutical manufacturing. Seven years into the U.S. Food and Drug Administration’s PAT (Process Analytic Technology) initiative, samples from production suites are still walked over to a wet lab, where their analysis can take hours, sometimes days.

For small-molecule drug making, Raman is used to image the distribution of ingredients in pills and to confirm the identity of raw materials at loading docks, but its application is nowhere as diverse as in broader industry. And despite having several

applications where Raman would be ideal, biotech manufacturing is still farther behind than small-molecule drug manufacturing.

A 2011 report from VTT Technical Research Centre of Finland notes that Raman has not been applied to bioprocessing despite being standard in other process industries.

One downside of Raman as an at-line or in-line bioprocess “laboratory,”

says Lee Smith, Ph.D., president of Process Instruments (Salt Lake City, UT), is the presence of highly colored or fluorescent

materials. “When present, they will swamp the weak Raman signal,” he says. A corollary is that Raman is not particularly sensitive below part-per-million concentrations.

In a bioreactor, Raman is capable of detecting analytes currently measured by sensors or off-line analysis (e.g., HPLC and LC-MS). Examples are glucose, lactate, glutamine, glutamate, cell density, osmolality, ammonium, and dissolved gases. Unlike off-line measurements, Raman provides numbers in real time.

A group at Biogen Idec (Weston, MA) recently reported the use of real-time Raman spectroscopy for measuring growth and metabolic profiles of mammalian cell cultures, as well as levels of cell metabolites.

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# STILL A RICH AREA FOR INNOVATION

Despite the technique's maturity, ultraviolet and visible (UV-Vis) spectroscopy has been a fertile area for innovation. The continuous xenon light source, which operates from UV to near-infrared, has been an enabling technology for UV-Vis, says Michael W. Allen, Ph.D., marketing manager for NanoDrop UV-Vis and fluorescence products at Thermo Fisher Scientific (Madison, WI). Xenon lamps replace older tungsten and deuterium lamps, which require extremely stable power supplies to deliver quality data.

The xenon flash lamp, a full-spectrum single source, remains on only during data acquisition. "This makes it a very long-lived source," says Dr. Allen. Thermo offers xenon flash lamps in most of its mid- to high-end UV instruments, as do most other vendors, who continue to sell tungsten and deuterium continuous-source lamps as well.

Another push has been to make instrument footprints smaller. Part of that trend has been the introduction of micro-volume instruments that generate full UV-Vis spectra on microliter-sized samples.

Micro-volume spectroscopy preserves precious samples, but that is not the driver for adopting this format, Dr. Allen says. "The critical factor is the convenience of not having to prepare a cuvette, pipette in the sample, wait for the spectrum

to run, and clean out the cuvette when it's all over." These workflow complications represent a barrier to fully utilizing traditional cuvette measurements for higher throughput applications, he says.

Unlike methods such as infrared and chromatography-mass spectrometry, UV-Vis is suited to analyzing known compounds. "The method's bread and butter is concentration measurements," Dr. Allen explains. Obtaining more informa-

**"Software and automation improvements have helped to turn UV-Vis instruments into true analyzers, as opposed to standalone instruments."**

tion out of a UV-Vis spectrometer, particularly in a field application, requires additional reagents or sample preparation. Even then, it comes nowhere close to "gold standard" techniques for unknown compound identification, like NMR and mass spectrometry.

Yet software and automation improvements have helped to turn UV-Vis instruments into true analyzers, as opposed to standalone instruments.

"Instrument makers have to focus not on the science and the spec-

troscopy, but on helping users get answers. That's where the field is going," says Dr. Allen.

For the vast majority of routine UV-Vis applications, adapting instrumentation for ease of use is the overriding trend.

UV-Vis instruments have become smaller as a result of microelectronics miniaturization, but were always limited by the instrument's components and pathways used for delivering radiation and measuring absorbance or transmittance.

Rob Morris, director of marketing at Ocean Optics (Dunedin, FL), sees bright days ahead for even more miniaturization and integration into what he terms Star Trek "tricorder-like" devices. Such handheld instruments might use filtering technology or spectral sensing to monitor just a few wavelengths (versus providing a full spectrum) for niche field applications. Connectivity to the Internet and radically redesigned user interfaces could help create virtual UV-Vis networks from nodes around the globe, with spectral libraries residing in the cloud.

Another change he sees is bundling all computing with the handheld instrument to eliminate the computer box altogether. One could imagine creating a global map of atmospheric conditions, such as ozone concentrations, from strategically placed cell phone-sized devices.

## BioTek's new Epoch Multi-Volume Spectrophotometer System

BioTek's new Epoch Multi-Volume Spectrophotometer System combines two innovative products into system designed for a wide range of applications, from nucleic acid and protein quantification on a micro scale to cell-based assays in microplates, BioCells or standard cuvettes. The Epoch Microplate Spectrophotometer offers a 200 nm to 999 nm wavelength range without interference filters for measurements in 6 to 384 well microplates, while the

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Take3 Plate extends the system's applications to very low volume nucleic acid and protein quantification. Up to sixteen 2 µL DNA, RNA or protein samples can be quickly quantified saving valuable time and samples. This system is well suited to the budget sensitive laboratory that needs maximum functionality and application flexibility.

The Epoch Microplate Spectrophotometer features a monochromator based optical system, with a wide 200 to 999 nm wavelength range, selectable in 1 nm increments. The main benefit is the ability to run a multitude of biomolecular assays without needing to purchase application specific filters. Controlled by the powerful Gen5 Data Analysis software, users need only to select the desired wavelength and read the microplate. When the assay wavelength is unknown, a spectral scan can be quickly run to determine the absorbance peak. Epoch can measure 6 to 384 well microplates with either a single data point taken in the center of the well, or by well area scanning in larger well diameters to provide multiple measurements that can be analyzed more closely. Measurements made in microplates can be corrected for pathlength by Gen5's automated pathlength correction option, which is an especially useful tool for direct quantification assays.

When used with the Epoch microplate reader, the Take3 Multi-Volume Plate extends applications

into the increasingly important low volume area. Take3 allows measurement of up to sixteen 2 µL samples at a time so that DNA, RNA or protein samples can be measured quickly and without diluting. The Take3 plate uses a custom designed fused silica slides, one of which is precision printed with sixteen 2 mm microspots — the ideal size for samples as low as 2 µL. When the top of the Take3 is closed, a nominal 0.5 mm pathlength is created so that sample concentrations can be quickly and accurately made with results produced automatically, via pre-programmed applications within the custom Gen5 Take3 module.

Together, Epoch and Take3 comprise a system that allows the laboratory an assay multi-tasking capability in one compact footprint at a fraction of the cost of typical instrumentation and in a fraction of the time that would be required to accomplish the same results.





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**How tubes can affect your experiments**

By Matthew Lieber, Dr. Lars Borrmann, and Daniela Marino

**Introduction**

It has been known for several years that chemicals (e.g., BPA and phthalates) can leach out of the plastic, such as toys and baby bottles. The impact of these chemicals on human health is well known. Recent scientific reports have now noted that chemicals used in the manufacturing of disposable plastic labware, such as slip agents or plasticizers, can leach out of the plastic and affect laboratory experiments leading to erroneous results.<sup>1-4</sup>

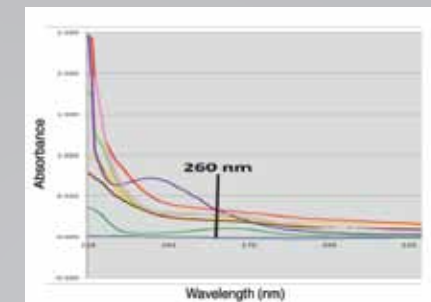
**What comes out of your tubes**

During incubation (e.g., enzymatic assays at 37°C or DNA denaturation at 95°C) chemicals used in the manufacturing process can leach out of the plastic and contaminate your sample.<sup>3</sup> Figure 1 shows the absorbance spectra of water after incubation in tubes from several different manufacturers. As you can see, in contrast to other brand tubes, the water incubated in Eppendorf tubes (blue line) shows no significant UV/VIS absorbance. This suggests that no UV/Vis active substances are released from the tube into the water. This is one of the examples of Eppendorf's commitment to minimize sample contamination. Besides highly automated manufacturing under clean-room conditions and purity testing of each production lot, Eppendorf doesn't use any slip agents, plasticizers, or biocides during the tube manufacturing process (certificate upon request).

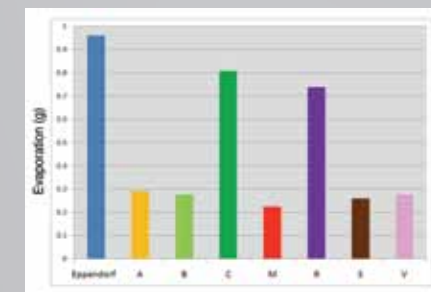
The next question to ask is how does leaching affect my experiment?

**How the type of tube can affect your assays**

It has been shown in several publications that the chemicals used during manufacturing of plastic consumables can affect assay results from DNA quantitation<sup>3</sup> to enzymatic assays.<sup>1,2</sup> In a Science paper from 2008, researchers showed that chemicals released from plastic tubes inhibited the activity of human monoamine oxidase-B (hMAO-B).<sup>1</sup> Important to note that the researchers used an amber-colored Eppendorf tube in that paper. When they switched to a clear Eppendorf tube, the results



▲ Figure 1. Chemicals released from different brands of 1.5mL tubes can contaminate your sample. Shown are UV absorbance spectra of pure water incubated (30min, 95°C, 1,400 rpm mixing) in tubes from different manufacturers.



▲ Figure 2. The brand of tube can affect evaporation rates. Chemicals, for example oily slip agents, released from the tube plastic can slow down evaporation. Some of these slip agents (e.g., oleamide) have also been shown to negatively affect the outcome of biological tests like enzyme activity or receptor-binding assays.<sup>1,2,4</sup> Shown are the evaporation volumes (in grams of water) after 3 h incubation in a vacuum concentrator. Pre-incubation for 1 hr at 70°C.

showed an absence of significant inhibition of hMAO-B.<sup>2</sup> Another important example is mass spectrometry. In a 2010 paper, researchers showed that Tinuvin-622 leaches from laboratory polypropylene and interferes with mass identification after MALDI-TOF.<sup>5</sup> Another common lab application is sample concentration. When samples need to be concentrated, it is common to use a vacuum concentrator to accelerate the evaporation of aqueous solutions. Figure 2 shows how incubating water in different brands of tubes can affect the evaporation rate of water. Samples incubated in Eppendorf tubes had the highest evaporation rate, consistent with the data shown in Figure 1. Both of these experiments and the Science paper lead you to the same conclusion: If you have a leachate you never know where it will affect you.

**Conclusion**

Not all tubes are created equal. If a chemical leaches out of the tube, it can carry over to all of your downstream applications and you will never know when it might affect your assays. One good summary on the importance of leaching comes from Reid et al. (2009): "There are several steps researchers can take to minimize the likelihood of their data being compromised by leachates. Some manufacturers provide information on the additives content of their plastics; for example, Eppendorf use virgin polypropylene for their colorless pipette tips and microfuge tubes, and no slip agents or other additives are present. Although the associated costs may be slightly higher, researchers should purchase plastic ware from a manufacturer that does not use additives and avoid buying from suppliers that refuse to confirm the absence of additives."<sup>2</sup>

**References**

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## PRECISION WEIGHING FOR STATIC, DYNAMIC APPLICATIONS

Analytical balances, which are accurate to at least 0.0001 g or 0.1 mg, represent the highest precision weighing standard for general use. Analytical balances also excel at quantifying changes in mass.

Software built into balances is a huge time-saver, says Tom Delano, business development manager at Adam Equipment (Danbury, CT). Software that performs calculations such as density or mass differences save operators many hours each week.

Because their mechanisms are delicate, analytical balances are sensitive to almost any mechanical or environmental disruption. Some

disconnecting it from the wall socket.

Analysts should take special precautions to ensure weighing accuracy. Users are urged not to handle samples with their bare hands, lest oils and moisture from the skin add to the sample's weight; leaning on the bench during weighing is another taboo, since vibrations can cause shifts in the balance's mechanism.

A single-cell, or "uni-block," weighing mechanism is becoming standard for high-end balances, particularly for labs that make repeated measurements that demand high accuracy. In a single-cell mechanism, the weighing pan consists of

tion, is useful for labs that perform weighing experiments over very long time periods or perform kinetics experiments involving the gain or loss of mass or whose sample masses change regularly over time. Automated drift compensation will change the baseline constantly and linearly, and only record changes that occur suddenly. Users can also program the balance to adjust for planned additions or withdrawals from the sample.

Other factors to consider before purchase, according to Dr. Kohn:

- Absolute capacity and resolution: how much are you weighing, and to what degree of accuracy?
- Do you need internal or external calibration?
- For very accurate work, buyers should consider a semi-micro analytical balance, with a resolution of 0.00001 g, or 0.01 mg.
- Availability of accessory sets for determining densities of solids or liquids.
- Compatibility with GLP/GMP or ISO record-keeping through a standard computer/printer interface.
- Automated calibration, which initiates at preset times or in the event of a potential interference such as rapid temperature change. Make sure the balance is "smart" enough not to begin calibrating in the middle of a weighing.

**"Because their mechanisms are delicate, analytical balances are sensitive to almost any mechanical or environmental disruption."**

of the more common sources of sample-associated error include condensation on cold objects, evaporation of volatile fluids, chemical reactivity, and convection from hot/cold objects. Systemic or external errors arise from drafts, temperature changes, vibration/ movement of the instrument or its environment, and static electricity.

Depending on usage, balance calibration may be carried out every few weeks or as often as twice during a shift. Lab workers should consider recalibration after noting fluctuations of more than about half a degree, moving the instrument, or

a single block that provides constant temperature, shorter stabilization times, and shockproofing. Single-cell weighing is accurate even when the sample is placed at the edge of the weighing pan.

"Single-cell is an advanced technology with fewer moving parts than conventional balances," says Rachel Kohn, Ph.D., a partner at Tovatech (South Orange, NJ). "This means the balance lasts longer [and] has shorter stabilization times, and corner-load performance is improved because response is uniform over the surface of the weighing pan."

Another feature, drift compensa-



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In virtually any industry, there is an ever-increasing need to process more samples in less time and with dependable results. While this demand has driven users to find better tools and methods, it has inspired Adam Equipment to develop the PMB moisture analyzers – two models that provide features and capabilities unlike any other, at affordable prices.

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# BALANCING SAFETY WITH ENVIRONMENTAL CONCERNS

With most manufacturers providing solid biological safety cabinets (BSCs), total cost of ownership has become a hot-button issue with purchasers. Until around 2000, exhaust fans were driven by AC permanent split capacitor motors. Manufacturers gradually switched to more advanced variable frequency drive AC motors that provided greater motor speed control. These have been standard for the last three or four years.

Since older motors did not compensate for filters clogging over time, airflows decreased between annual certifications, compromising contamination control and user safety. In newer cabinets, motors speed up to maintain a constant air velocity into or out of the cabinet. “The coolest thing about them is they are anywhere from 50 to 75 percent more energy efficient than the older models [...] and they’re much safer,” says David Phillips, a technical applications specialist at Thermo Fisher Scientific (Asheville, NC).

Although the new motors are costlier than older models, this has not been reflected in the overall price of a new BSC, Mr. Phillips adds. Energy savings can be as high as \$800 per year per cabinet.

Environmental consciousness has become a major driver behind abandoning AC motors for DC

designs. But as Mike Martin, general manager at ESCO Technologies (Hatboro, PA) notes, the AC-DC issue is far from straightforward. “DC motors draw fewer amps when filters are new or clean. AC motors draw higher amps with clean filters, but fewer as the filters load.”

Regardless of motor type, BSCs should have a means of compensating for filter loading, and provide enough reserve motor capacity to

**“Environmental consciousness has become a major driver behind abandoning AC motors for DC designs.”**

maintain at least 90 percent of maximal air flow as filters clog. Otherwise safety is compromised and downtime increases due to the need for more frequent decontamination and filter changes.

Unlike most laboratory products, BSCs are not “user serviceable.” Since filters often harbor biohazardous material, they are swapped out regularly by accredited, certified, third-party service professionals who also decontaminate the BSCs, adjust any settings required due to installing fresh filter media, and certify

the cabinet is operating properly. Certification involves written and practical testing, continuing education, and periodic retesting.

One thing technicians are doing a lot less of these days is replacing motors. Older designs were rated at 10,000 to 15,000 hours of service before requiring rebuilding or replacement. In the last few years, motors rated at 50,000 hours and higher—Thermo claims 100,000 hours—have become standard.

Perhaps the most critical feature is external exhaust. Cabinets that handle toxic gases require venting, but some labs may specify venting for general safety purposes.

External exhausting significantly raises the complexity of designing and building the BSC and entails a “hidden” cost for facilities in terms of the removal of expensive conditioned air.

Modern BSCs come in standard sizes with much improved usability compared to a decade ago. Manufacturers have implemented ergonomic improvements, such as slanted fronts, to provide greater accessibility. Buyers should look for NSF certification, energy consumption and service requirements.

And, as Martin suggests, since test documentation may be hard to come by, they should ask a lot of questions.

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# CHOOSE BASED ON SAMPLE SIZE AND VISCOSITY

Mixing is ubiquitous in industrial, academic, and industrial laboratories. The choice of overhead or magnetic stirring to achieve uniform mixing is based on the scale and viscosity of the medium being stirred.

Commercial labs often “scale down” large manufacturing processes that involve mixing combinations of water, organic solvents, and soluble and insoluble materials to create solutions, suspensions, slurries, syrups, pastes, and creams; others work with inherently viscous materials such as polymers.

Then there is the whole other world of small-scale chemistry, biology, and analytical laboratory operations associated with basic research, or in support of production or manufacturing research and development.

These two scenarios closely approximate the domains of overhead mechanical stirrers and magnetic stirrers, respectively. Or as Charles Villano, sales and marketing manager at Kinematica (Bohemia, NY), says, “Overhead stirrers are used when sample viscosity and/or size are issues, or when there exists a concern for significant changes in viscosity.”

Overhead units are common in the food, material science, cement, adhesives, polymers, and energy industries.

Basic overhead stirrers consist of a drive mechanism or motor, control-

ler, drive shaft, and stirring fixture or panel. Stirrer configurations include propellers, either x-shaped, anchor shaped, or flat panels, each appropriate for specific applications. Materials of construction are often critical

**“Sizing an overhead stirrer for a specific application is part art, part science.”**

as samples may be acidic, basic, or otherwise corrosive. For example, stainless steel or glass rods are common in the food industry, as are inert materials such as Teflon.

Data- and documentation-hungry labs have demanded feature-rich overhead stirrers, and manufacturers have met the challenge. Most stirrers today sport digital panels that display stirring element rotation and applied torque; many connect to computers, which log this information, via RS232 or USB ports. Torque applied to mix a sample is directly proportional to the sample’s viscosity.

These amenities are useful for unattended or automated operations, particularly when viscosity differences indicate endpoints. Mr. Villano estimates that about 20 percent (and growing) of overhead stirrer applications are integrated into processes via computer control.

Sizing an overhead stirrer for a specific application is part art, part science. “You can buy a 50-watt motor that says it can mix two liters, but if your material is viscous it may only

handle 500 mL,” Mr. Villano explains.

While technologically more complex than overhead stirrers, magnetic stirrers are easier to use and set up and possess greater functionality.

Magnetic stirrers use a drive magnet that causes a magnetically susceptible stir bar to rotate inside a flask or beaker. The stir bar core is coated with either glass or Teflon for easy clean-

ing. Most magnetic stirrers incorporate a heating element that operates independently of the stirrer.

“Stirrer-hotplates are definitely more convenient than overhead stirrers,” Mr. Villano observes, “but they’re mostly for smaller-volume organic chemistry labs or aqueous-based processes.”

Buyers also have the choice between round- or rectangular-bottomed stirrer-hotplates.

Round stirrer-hotplates more closely match the bottoms of Erlenmeyer flasks and beakers, which are round, and therefore take up less room. “Heat transfer is also better with round models,” says Refika Bilgic, managing director at IKA (Wilmington, NC). “But rectangular models can accommodate more labware.”

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SANYO [www.sanyo.com](http://www.sanyo.com)

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THE GRAVITY OF IT ALL

Centrifuges separate particles and structures suspended in liquid by applying thousands of gravitational force equivalents to the sample through spinning. Laboratories use centrifuges to clarify suspensions, separate liquids, isolate suspended particles, perform density measurements, and for many other applications.

Many users, and some manufacturers, specify centrifuges and centrifugation in terms of rotor revolutions per minute (rpm), but as Dr. Lars Borrmann, group marketing manager at Eppendorf (Hauppauge, NY), notes, rpm is a vague term that says nothing about separation power:

“Customers still ask about rpm, but that only tells you what the motor can do and nothing about the force being applied.”

Currently, the operative term is RCF, relative centrifugal force, a function of rotor radius and the square of the rotational speed. Two centrifuges with the same RCF provide comparable resolving power. Transferring methods between centrifuges is difficult without knowing the instruments’ RCF values.

Dr. Borrmann places centrifuges into two basic categories: inexpensive instruments that provide basic speed and capacity, and ergonomic and “eco-friendly” units.

Labs are noisy, with numerous devices contributing to the din. A loud centrifuge can tip the noise balance into the intolerable range. “You don’t want a screaming loud instrument right next to where you’re working,” Dr. Borrmann says.

Accessibility is another often-overlooked ergonomic issue. Dr. Borrmann advises buyers to consider units with a low profile and easy-open-and-close lids for increased safety. The final ergonomic consideration is ease of operation.

For Maurizio Merli, senior product manager for benchtop centrifuges at Thermo Fisher Scientific (Milford, MA), improved construction materials have been the most significant trend in centrifugation, providing levels of biological and workplace safety that did not exist 15 years ago.

When a centrifuge spinning at tens of thousands of rpm crashes, the device becomes a kind of centrifugal fragment bomb that can destroy a lab and cripple or kill anyone nearby. Most units today employ high-quality covers and paneling to keep flying metal inside.

even better by providing the highest strength-to-weight ratings.

Most use glass-reinforced plastics, similar to materials used to make surfboards and aircraft. Carbon fiber-based composites do an even better job, according to Mr. Merli. Carbon fiber rotors are stronger than metal of equivalent weight, contain potential biological hazards better than do conventional rotor designs, and resist corrosion—a major source of catastrophic failure and centrifuge crashes.

Industrial and regulated applications are driving the application of data logging in centrifugation, observes Randy Pawlovich, strategic marketing manager at Beckman Coulter (Indianapolis, IN). “In the old days, the traditional customers were research and academic labs and data wasn’t a big deal.” Today, he says, regulated industries (like diag-

“When a centrifuge spinning at tens of thousands of rpm crashes, the device becomes a kind of centrifugal fragment bomb that can destroy a lab and cripple or kill anyone nearby.”

Manufacturers have focused on rotor design to minimize the effects of a crash, particularly for high-speed units. Aluminum alloys and lightweight metal amalgams provide mechanical integrity and high performance. Composite rotor materials, which Thermo has pioneered, do

nostics) routinely collect centrifuge operation data.

Even in non-regulated settings, companies facing tight budgets are documenting who uses instruments and for how long, and what mishaps may have occurred during a particular run.

RECENTLY RELEASED CENTRIFUGES

Allegra X-30 Series Benchtop

- 18-inch-wide instrument is now available individually or packaged with the appropriate rotors and labware to provide high-level performance in a range of applications
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- Offers intuitive operation and large interface



Beckman Coulter [www.beckmancoulter.com](http://www.beckmancoulter.com)

Mini

- Includes three rotors: a 6 x 1.5mL rotor, a PCR Strip rotor and a 1" x 3" slide rotor
- Also includes two adapters for 0.5 to 0.65mL and 0.4mL
- Features a safety interlock which automatically shuts off unit when lid is opened
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CENTRIFUGE MANUFACTURERS

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The MF 20 / MF 20-R series, 4 x 200 ml, is designed to suit all your needs: AWELock rotor exchange without tools and large choice of accessories from 36 x 5/7 ml sample tubes swing-out rotor to 30 x 1.5 ml and 8 x 50 ml angle rotors.

The MF 48 / MF 48-R Series optimize dimensions for 60 tube capacity and a large range of accessories to meet all your requirements up to 13,800 rpm. Programmable acceleration and braking rates allow perfect control of the centrifugation cycle. Refined ergonomics: convenient working height, AWELight illuminated handle to indicate end of run, motorized lid opening.

NuAire with Awel are dedicated to developing and delivering innovative products, establish trust in both products and personnel, seek customer satisfaction, and to continuously improve.



# MAINSTAYS OF CELL, TISSUE CULTURE, AND MICROBIAL TESTING

Carbon dioxide (CO<sub>2</sub>) incubators are mainstays in traditional biology labs engaging in cell or tissue culture. Incubators provide a stable environment designed to mimic a cell's natural environment: pH of 7.2 to 7.5, temperature of 37°C, and a relative humidity of about 95 percent. The CO<sub>2</sub> concentration, about 5 percent, is controlled to match physiologic conditions and to maintain a constant pH.

Incubators are used wherever cells must be maintained, expanded, or cultured over periods ranging from a few hours to many weeks.

Deepak M. Mistry, manager for strategic development and marketing at Sanyo (Wood Dale, IL), notes that an upswing in biological therapeutics and stem cell research has created additional demand for high-performance CO<sub>2</sub> incubators.

The need to validate incubator operations and cleaning for regulated work is a driving force behind the tight control over conditions inside incubators. Conditions inside an incubator change rapidly when someone opens the door to introduce or remove samples. In some cases, the health or viability of cells may be compromised. Sanyo and other companies use infrared sensors that automatically measure the CO<sub>2</sub> concentration and initiate re-equilibration of gas concentration.

Maintaining cleanliness inside an

incubator is of prime importance, particularly for units that house several cell lines at once or change over samples rapidly. Incubators, after all, provide ideal growth conditions not just for cells of interest but for invasive fungi, yeast, and bacteria.

Traditionally, disinfection is achieved via heat or ultraviolet (UV) light. Heat is effective, but energy-intensive and stresses materials of construction. UV also works quite well, but only on line of sight: nooks and crannies not directly irradiated may remain contaminated.

**“Incubators are used wherever cells must be maintained, expanded, or cultured.”**

Sanyo has pioneered the use of hydrogen peroxide gas for incubator disinfection. Gas permeates every surface area within the box and provides close to 100 percent kill of pathogens. The company claims that cycle time between removal of cells, cleaning, and introduction of new cells is about two hours after peroxide disinfection.

Maintaining the health of cultured cells used in research or biomanufac-

turing is of utmost importance—not just while they're in the incubator, but during use and storage. “Since cell lines can take weeks or months to make, they're very expensive,” Mistry says. “Users expect them to be viable for many months after they leave the incubator.”

David Craig, product manager at BINDER (Bohemia, NY), sees increasing demand for tri-gas incubators – traditional CO<sub>2</sub> devices that incorporate oxygen control. Oxygen normally ranges between 15 percent and 20 percent by volume; here O<sub>2</sub> is as low as 0.2 percent.

The term “tri-gas” refers to separate hookups for CO<sub>2</sub>, nitrogen and oxygen.

BINDER specializes in hot air sterilization, which occurs at 180°C. “The next closest, decontamination at 140 degrees, doesn't remove everything, while disinfection at 90 degrees just knocks down some organisms. You need at least 170 degrees to eliminate not just microorganisms and cells but DNA.”

Hot air sterilization practically eliminates condensation—a breeding ground for microorganisms—and does not require the use of HEPA filtration. HEPA units are expensive and are another potential source of contamination.

## RECENTLY RELEASED CO<sub>2</sub> INCUBATORS

### C Series

- Provides hot air sterilization at 180 °C
- Includes seamless, deep-drawn inner chamber made of stainless steel
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## CO<sub>2</sub> INCUBATOR MANUFACTURERS

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<b>Wheaton</b>	<a href="http://www.wheatonsci.com">www.wheatonsci.com</a>
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<b>Z-sciences</b>	<a href="http://www.z-sciences.com">www.z-sciences.com</a>

## Perfect Climates for the Lab

BINDER Inc. offers a range of environmental simulation equipment that provides consistent performance — a quality that allows a focus on the research at hand and confidence in the equipment holding samples. CO<sub>2</sub> Incubators, Environmental Chambers, Ovens and Incubators form the core of a quality line-up with a range of unique features that puts samples safely in a climate tailored just for their needs. These units all feature APT.line™ preheating chamber technology as the underlying technology that delivers highly accurate temperature performance in both the scientific and industrial laboratory, and in both routine applications and in highly specific work.



Best conditions for your success

545-3 Johnson Ave.  
Bohemia, NY 11716  
[www.binder-world.com](http://www.binder-world.com)  
866-885-9794

### CO<sub>2</sub> INCUBATORS

A 180 °C hot air sterilization cycle that completely sterilizes the unit interior over nine hours is the most prominent of many distinguishing features built into a BINDER CO<sub>2</sub> incubator. The Permadyr® condensation-free double-pan humidification system maintains dry interior walls while the incubator operates at relative humidity of approximately more than 95%. CO<sub>2</sub>/air mixture is injected via a patented cross-flow mixing valve and distributed homogeneously throughout the chamber. An infrared sensor selectively measures CO<sub>2</sub> concentration in real-time, enabling precise control of CO<sub>2</sub> levels, and thus over media pH, resulting in optimal cell growth. The standard model includes an automatic self-diagnostic system with visual and audible alarm functions. There is an option available for O<sub>2</sub> control, which allows tri-gas control for sustaining hyperoxic conditions.

### ENVIRONMENTAL CHAMBERS

BINDER offers chambers for climate testing, environmental simulation, and for stability and material testing. Available in a range of sizes, the units provides temperatures ranging from -70 to 180 °C, without humidification and 10 to 95 °C with humidification. A variety of chamber sizes accommodate a range of volume requirements. Where needed, units are provided with interior lighting for photostability testing. Whatever the test requirements and whatever the compartment

load, conditions remain uniform throughout. Options available across the line include pure water service, installation of access ports, specimen-temperature measurement, and others.

### OVENS AND INCUBATORS

Heating ovens, safety drying ovens, vacuum drying ovens, incubators and cooling incubators from BINDER provide optimal conditions for samples and the performance, safety and ergonomic features inherent in all BINDER products. With chamber capacities ranging from 0.7 to 25.4 cu ft, there are units available in the size needed for every lab. Oven temperatures range as high as 350 °C, and incubator temperatures range from 5 to 100 °C.

### BEST CONDITIONS FOR YOUR SUCCESS

APT-COM™ Software is available as an option in Basic, Standard and GLP editions for all BINDER environmental control equipment, and provides comprehensive process monitoring at the level required by any individual lab. Users will find unmatched construction and performance characteristics throughout the line, providing the best possible conditions for their success.



▲ A BINDER CO<sub>2</sub> incubator. The divided chamber is used when culturing under hyperoxic conditions.



▲ Stability chambers incorporate an inner glass door — a feature common to many BINDER products — that allows samples to be viewed without compromising the environment.



# CONTROL AND INTERFACE OPTIONS IN A MATURE PRODUCT CATEGORY

Despite their maturity as a product category, chillers and baths continue their slow evolution, particularly in terms of controls and user interface.

Cole-Parmer (Vernon Hills, IL) and other vendors provide units with a temperature stability of 0.1°C that use force-only (also called force gravity) or force-suction pumping.

The pumping mode depends on the application. The force-only mode pumps fluid out and relies on gravity to deliver fluid back to the inlet, whereas force-suction pumps push the bath fluid out and then actively draw it back into the pump. “Force suction provides stronger, more robust pumping,” says Ben Wilbert, product group manager at Cole-Parmer. “Particularly with viscous thermal fluids, or when you are pumping out to an open or closed external loop where you need more pressure or velocity.”

“External loop” refers to an external device or vessel that aids in temperature control. If the fluid flows into an open vessel, the process would be termed “open-loop”. But if the flow line is contained, such as with radiator coolant in a car, then it’s described as a “closed-loop” application.

Controller options for chillers and baths have multiplied well beyond digital/analog. Advanced controllers offer a greater number of programmable setpoints, greater temperature control, higher circulation capacity, touchscreen

options, and a USB port for controlling the device from a computer.

A greater demand for traceability and data logging has given rise to a variety of communication protocols applicable to chillers and baths – Ethernet, USB-A, USB-2, RS242, and RS-485 interfaces. Some can even communicate wirelessly with an iPhone or other handheld device.

Within the heating and cooling products marketplace, Sheldon

**“Controller options for chillers and baths have multiplied well beyond digital/analog.”**

Manufacturing (Cornelius, OR) specializes in water baths, including entry-level digital baths, high-temperature baths, and specialty models.

Although the company does not manufacture chillers, it has adapted cooling recirculation technology to one of its CO2 incubator models for customers who wish to operate at or below ambient temperature.

In a conventional water-heated incubator, the working volume is surrounded by an insulating chamber containing water. In this retrofitted product, coils are inserted into the insulating chamber and circulated

to an external chiller that maintains the insulating chamber at a preset temperature.

“Circulating water through an external chiller constantly cools the incubator similar to how coils cool down a refrigerator,” says Mike McLane, Sheldon sales director. “But you don’t have the problem of dealing with a compressor.”

Manufacturers have also already deployed new materials for chillers and baths, such as clear plastics and composites, while upgrading refrigeration compressors to be more energy-efficient and utilize less environmentally harmful compressor gases.

Next to advanced controllers, user interface improvements have been the top technological upgrades in chillers and baths. “Ten years ago, chillers featured LED screens, then LCD displays that held more information,” says Joseph Costello, Grant Instruments (Hillsboro, NJ) North American sales and marketing manager. “Today we have touch screens and membrane-covered controls, smooth surfaces that keep water out.”

But users, Mr. Costello says, are more likely to purchase based on the interface rather than advanced controls because instruments from reputable manufacturers already provide adequate temperature control and uniformity.

## RECENTLY RELEASED CHILLERS & BATHS

### RCB20-PLUS Refrigerated/Heated Circulation Bath

- Temperature control ranges from -10°C to +100°C and regulated to ±0.03°C
- 12 L per minute circulation pump rate
- Outfitted with a low liquid volume sensor to prevent damage to unit
- Compressor uses R134A refrigerant and includes a sensor that identifies irregular temperatures



Hoefer  
[www.hoeferinc.com](http://www.hoeferinc.com)

### LS Series Benchtop Chillers

- Optimized for high performance at low temperatures
- Capable of cooling multiple rotary evaporators
- Features WhisperCool environmental control system
- Includes large, easy-to-read LED display
- Space-saving design



PolyScience

[www.polyscience.com](http://www.polyscience.com)

### Julabo SW23

- Temperature stability of ±0.2 or ±0.02 °C
- Adjustable shaking frequency 20 to 200 rpm
- Many accessories including lids, flask & rack holders
- Dry-running safety protection
- Removable shaking insert



Julabo

[www.julabo.com](http://www.julabo.com)

### EchoTherm™ RIC20 Series Chilling/Heating Dry Bath

- Settable from -20.0°C TO 110.0°C
- Allows the user to run their complex temperature/time profiles by leaving the computer attached to the RIC20
- Takes up as little bench space as possible with the units measuring 6.5" (165 mm) long by 4.75" (120 mm) wide by 3.5" (89 mm) tall without a sample block.



Torrey Pines Scientific

[www.torreyпинesscientific.com](http://www.torreyпинesscientific.com)

## CHILLER & BATH MANUFACTURERS

Boekel

[www.boekelsci.com](http://www.boekelsci.com)

Cincinnati Sub-Zero

[www.cszindustrial.com](http://www.cszindustrial.com)

EYELA

[www.eyelausa.com](http://www.eyelausa.com)

Grant Instruments

[www.grantsci.com](http://www.grantsci.com)

Hoefer

[www.hoeferinc.com](http://www.hoeferinc.com)

JeioTech

[www.jeiotech.com](http://www.jeiotech.com)

Julabo

[www.julabo.com](http://www.julabo.com)

Lab Armor

[www.labarmor.com](http://www.labarmor.com)

Legacy Chiller Systems

[www.legacychillers.com](http://www.legacychillers.com)

PolyScience

[www.polyscience.com](http://www.polyscience.com)

TECA Corporation

[www.thermoelectric.com](http://www.thermoelectric.com)

TEK-TEMP Instruments

[www.tek-tempinstruments.com](http://www.tek-tempinstruments.com)

Thermo Scientific

[www.thermoscientific.com](http://www.thermoscientific.com)

Torrey Pines Scientific

[www.torreyпинesscientific.com](http://www.torreyпинesscientific.com)

VWR

[www.vwrsp.com](http://www.vwrsp.com)

# NECESSARY FOR SAFETY BUT ENVIRONMENTALLY ‘INVISIBLE’

Choice of clean room casework, or furniture, is one of the most important decisions made when setting up classified space. Cabinets and associated doors, hinges, handles, panels, benchtops, shelving, and vertical/horizontal surfaces must be compatible with the application and the clean room’s classification by Federal Standard 209E for airborne particulate cleanliness. Surfaces must be as easily cleaned as walls and floors, emit no particulate contaminants, and above all resist exposure to liquids and solids processed inside the room. Since the purpose of a clean room is to protect the environment from hazardous materials or sensitive materials from the environment and humans, or both, clean room casework must fulfill those missions and be environmentally “invisible.”

Most clean room casework today is made from coated steel, stainless steel, and polypropylene. Polypropylene casework has been around for years, remaining a niche product due to its high cost, but Terry Thompson, polypropylene sales manager at NuAire (Plymouth, MN) says poly-

propylene is the material of choice for clean rooms that use corrosive acids or chemicals or that experience high humidity.

Polypropylene is about 2.5 times as expensive as steel or wood casework and just slightly more expensive than stainless steel. As Thompson explains, “Polypropylene is made from a petroleum product, so we’re at the mercy of the oil markets. But more important, a polypropylene cabinet needs a lot of handling during manufacture—much more than stainless steel... Polypropylene edges are sharp and must be smoothed and deburred, then welded together.”

Clean room casework is normally specified by whoever plans the room, which is either an architect or a company engineer. Owners increasingly ask for modular casework, Thompson explains, because it provides versatility and changeover capability when a clean room’s mission changes.

Outside design firms sometimes over specify for casework, Thompson says, to cover all contingencies. In one instance where polypropylene casework was designated, Thompson called the owner to confirm that the application called for it. “They didn’t realize how expensive it was and wound up ordering a less costly alternative that suited their needs just as capably. If you can get by with metal casework, that’s obviously the way to go.”

Hemco specializes in Class 1000 and Class 10,000 clean room furnishings and installations, a niche that Campbell describes as “clean labs” to distinguish them from higher-class semiconductor processing suites. Hemco has done Class 100 installations, but usually as sub-areas of Class 1000 rooms. Within that marketplace the company sells casework fashioned from welded steel coated with an epoxy powder coat finish. These structures are fabricated as easily as stainless steel but have much higher resistance to acids and moisture. They are also available for about one-third the cost of polypropylene and stainless.

**“Owners increasingly ask for modular casework, Thompson explains, because it provides versatility and changeover capability when a clean room’s mission changes.”**

## RECENTLY RELEASED CLEANROOM PRODUCTS

### Class 10,000 Cleanroom

- A hard wall 20' x 30' ISO 7 single pass cleanroom with dual 36" pass-thru ports and a gowning room
- Provides a contaminant-free manufacturing environment for the company's probes, fluid heaters and custom fluidic assemblies
- Filters air using high efficiency particulate air and ultra-low particulate air filters



Diba Industries

[www.dibaind.com](http://www.dibaind.com)

### Compounding Cleanroom USP 797 Compliant

- An ISO 5 (Class 100) primary processing (buffer) area with three HEPA filter/fan units provides a total of 1950 CFM (3315 m³/hr) of 99.99% particle-free air
- Sliding clean vinyl curtain creates a separate antechamber for personnel gowning or product staging
- Stainless steel trim is easily sterilized, and panels stand up to alcohol and other biocides



Terra Universal

[www.terrauniversal.com](http://www.terrauniversal.com)

### Model #VSW Vertical Sliding Pass Thru Window

- Available in custom widths and heights and is a mere 2-1/4" in depth, taking up very little space
- Also available in 304 or 316 stainless steel with glass, clear plastic, or opaque panels
- Easy to open and is held open by counterbalances tuned to the window weight
- Easily installed within minutes



Liberty Industries

[www.liberty-ind.com](http://www.liberty-ind.com)

### Series 64 Perforated Stainless Steel Cleanroom Tables

- Allow uniform airflow through the work surface, and eliminate eddies and stagnant air pockets that are on or above the work surface of solid-top tables
- Feature a stainless steel support frame and are ideal for vertical flow cleanroom applications
- Continuous-top and perimeter-frame models are available



Clean Air Products

[www.cleanairproducts.com](http://www.cleanairproducts.com)

## CLEANROOM PRODUCT MANUFACTURERS

American Cleanroom Systems	<a href="http://www.americancleanrooms.com">www.americancleanrooms.com</a>
BEVCO	<a href="http://www.bevco.com">www.bevco.com</a>
Clean Air Products	<a href="http://www.cleanairproducts.com">www.cleanairproducts.com</a>
CleanAir Solutions	<a href="http://www.cleanroomspecialists.com">www.cleanroomspecialists.com</a>
Clean Rooms West	<a href="http://www.cleanroomswest.com">www.cleanroomswest.com</a>
Diba Industries	<a href="http://www.dibaind.com">www.dibaind.com</a>
Gerbig Engineering Company	<a href="http://www.gerbig.com">www.gerbig.com</a>
HEMCO	<a href="http://www.hemcocorp.com">www.hemcocorp.com</a>
Liberty Industries	<a href="http://www.liberty-ind.com">www.liberty-ind.com</a>
PortaFab	<a href="http://www.portafab.com">www.portafab.com</a>
Sovella	<a href="http://www.sovella.us">www.sovella.us</a>
Terra Universal	<a href="http://www.terrauniversal.com">www.terrauniversal.com</a>
United Lab Equipment	<a href="http://www.unitedlabequip.com">www.unitedlabequip.com</a>



# DATA SYSTEM INTEGRATION, BUT SLOW ADOPTION BY SMALL LABS

“Informatics convergence” has become a buzzword among ELN vendors and their customers. According to Steven Eaton, marketing manager for chemical analysis and informatics at Waters Corporation (Milford, MA), convergence encompasses an information environment in which the ELN is one component. Waters, for example, positions its ELN as part of its platform SDMS (scientific data management system).

“ELNs are not just replacements for paper notebooks, but facilitators that close the electronic gaps between and among data systems,” says Mr. Eaton.

Another noteworthy trend is the expansion of traditional ELN functions, particularly with respect to inventorying and sample management—competencies normally associated with laboratory information management systems (LIMS).

Integration has become critical for QA/QC. Pharmaceutical QC testing involves 40 manual transcriptions of instrument data. “With an error rate of between three and five percent, almost every record contains an error,” Mr. Eaton observes. By reading data directly from instruments, ELNs eliminate errors and costly retesting while streamlining data review.

One characteristic that ELNs have maintained over the years is application-specificity. “There is no one-size-fits-all ELN,” says Mr. Eaton. “I doubt we’ll ever see one that

serves quality, biology, and chemistry workflows.”

John Newtown of LabWare (Wilmington, DE) views centralization and consolidation of laboratory data systems as an essential and inevitable consequence of the complexity of the data that labs generate and the systems employed to manage that information.

Some companies use LIMS in one lab, an ELN in a second lab, and more conventional data capture in others. “Customers are demanding consolidation while emphasizing centralization and reuse of data,” he says. “The trend is definitely fewer systems, not more, and simplification through harmonization and centralization.”

According to a study by Atrium Research, just four percent of academic labs have adopted ELNs. Of adopters, 60 percent are chemistry labs, which lately have been urged by industry to use ELNs.

Why is there such low penetration at universities? Cost, inertia, and information technology complexity all come into play. To these issues, Prof. Jerry Wright of the Johns Hopkins School of Medicine adds scaling capabilities, user interface, customization, control of data sharing, image management, version control, and electronic signatures.

Academic labs do not feel the same kinds of productivity pressures as industry. Atrium cites a 20 percent improvement in throughput for ELN users, which is significant for high overhead industries. But faced with productivity bottlenecks, academics tend simply to work longer hours. Similarly, intellectual property

“One characteristic that ELNs have maintained over the years is application-specificity.”

protection, data verification, and validation are paramount in industry (particularly regulated ones) but of far less significance at schools.

While adapting ELNs to small research labs has been challenging, Web-based ELNs appear to suit academic laboratories particularly well. But even then, coaxing “temporary workers” to use them is difficult. A post-doc may spend one or two years in a lab, during which time he or she expects to publish several papers. “When you have one year to accomplish everything, detailed record keeping gets in the way,” says Dr. Wright. Given the choice between experimentation and learning a new software system, most researchers will select the former.

## RECENTLY RELEASED ELECTRONIC LABORATORY NOTEBOOKS

### Symyx Notebook v. 6.6

- Enables cross-disciplinary teams to collaborate more effectively using validated and compliant processes
- No custom coding is required
- Offers configurable capabilities for analytical, process and formulation teams working in small and large molecule development

Accelrys

[www.accelrys.com](http://www.accelrys.com)

### eCAT

- Lets users create and import research data
- Allows controlled sharing of data between lab members
- Enables lab members to communicate using messages and tasks
- Gives lab members the ability to work from home or when traveling, in a secure, integrated collaborative environment

Axiopex

[www.axiopex.com](http://www.axiopex.com)

### OpenLAB

- Brings applications, instruments and data together under a single lab environment
- Consists of three integrated solutions: Chromatography Data System (CDS), Electronic Lab Notebook (ELN) and Enterprise Content Management (ECM)
- Supports virtually any chromatographic technique, providing control of instruments
- Facilitates multi-discipline interaction and cross-team collaboration

Agilent

[www.agilent.com](http://www.agilent.com)

### Flagship

- Provides Cloud or “local” software platform for storage and collaboration of laboratory data
- Web-based SaaS product allows all users to be automatically upgraded to the latest edition at no charge
- Licensed LabArchives users on a local server also receive upgrades free of charge
- New release enables users to directly store their experimental data and analysis into LabArchives notebooks
- Available in both Free and Premium versions

LabArchives

[www.LabArchives.com](http://www.LabArchives.com)

## ELECTRONIC LABORATORY NOTEBOOK MANUFACTURERS

AJ Blomesystem GmbH [www.blomesystem.com](http://www.blomesystem.com)

Accelrys [www.accelrys.com](http://www.accelrys.com)

AgileBio [www.agilebio.com](http://www.agilebio.com)

Agilent [www.agilent.com](http://www.agilent.com)

Ambidata [www.ambidata.pt](http://www.ambidata.pt)

Axiopex [www.axiopex.com](http://www.axiopex.com)

Computing Solutions Inc. [www.labsoftlims.com](http://www.labsoftlims.com)

ChemWare Inc [www.chemware.com](http://www.chemware.com)

iPad ELN [www.ipadeln.com](http://www.ipadeln.com)

LabArchives [www.labarchives.com](http://www.labarchives.com)

LabLite [www.lablite.com](http://www.lablite.com)

LabLynx [www.lablynx.com](http://www.lablynx.com)

LabPlus [www.labplustech.com](http://www.labplustech.com)

LabVantage [www.labvantage.com](http://www.labvantage.com)

LabWare LIMS [www.labware.com](http://www.labware.com)

Modul-Bio [www.modul-bio.com](http://www.modul-bio.com)

Novatek <http://ntint.com>

PerkinElmer [www.perkinelmer.com](http://www.perkinelmer.com)

Promium [www.promium.com](http://www.promium.com)

Ruro [www.ruro.com](http://www.ruro.com)

Sapio Sciences [www.sapiosciences.com](http://www.sapiosciences.com)

STARLIMS [www.starlims.com](http://www.starlims.com)

Systat Software Inc. [www.systat.com](http://www.systat.com)

Thermo Scientific Informatics  
[www.thermoscientific.com/informatics](http://www.thermoscientific.com/informatics)

# ROTARY EVAPORATORS

For decades, rotary evaporators have been staples in labs and industries performing chemistry, including labs in the chemical, environmental, materials, life science, and forensics industries. Key applications include sample concentration, solvent recycling, extractions, and separation of solvent mixtures.

In their simplest embodiment, “rotovaps” consist of a temperature bath, rotating flask, condenser, collection flask, and vacuum source. Solvent distills from the sample under the combined effects of heat and vacuum, and collects after condensation in the collector. Recovered single-phase organic solvents may be dried and re-used; binary, tertiary, or quaternary solvent mixtures are also re-used but may need adjustment for composition.

Water is the fluid of choice for the bath, but some laboratories use oils to reach heating temperatures of up to 180°C. Several choices are available for the condenser coolant. Chillers provide more precise cooling, greater control over condensation, a greatly reduced environmental footprint, and overall are less expensive to use than water. High-efficiency trapping of low-boiling solvents is achieved with a “cold finger” charged with dry ice and acetone.

Vacuum is probably the broadest rotovap option. At one time, water aspirators were the most common vacuum sources. That

practice has gone by the wayside due in part to environmental concerns related to solvent vapors venting down the drain.

The next most common source is house vacuum, which is limited but inexpensive and reliable. Users typically insert a Woulff bottle or cold trap between the vacuum spigot and the rotovap, to trap volatiles the condenser missed and protect the house vacuum system.

Increasingly, users employ vacuum pumps to achieve reproducible and rapid solvent removal. The vacuum must be applied carefully, however, to avoid problems.

**“Increasingly, users employ vacuum pumps to achieve reproducible and rapid solvent removal.”**

Users are now turning to more sophisticated vacuum control, which Kristof O'Connor, product manager at Heidolph Brinkmann (Elk Grove Village, IL), describes as “probably the number-one improvement in rotary evaporators over the past two decades.” Control became necessary, he says, because “vacuum pumps are very stupid machines. They try to achieve as high a vacuum as they can, as quickly as possible, which often results in bumping and foaming.”

Newer rotovaps may incorporate thermocouple-controlled operation, in which a pump integrates with a controller and a thermocouple located near the condenser coils. As

the coil temperature rises through heat transfer between the condenser and the evaporated solvent, the vacuum is bled out through valving to maintain steady distillation. Another technique, known as “RPM” control, speeds or slows the pump’s inner workings to control the delivered vacuum.

Systems integration is also important in rotovaps. In such an arrangement, the main components of the evaporation solution are fully integrated with respect to parameters and control. The benefits include: up to 75 percent reduction in energy consumption, reduced heat emissions in the lab, optimized distillation capacity, and increased process safety.

Buyers should consider several vacuum and condenser cooling options before buying a rotovap. Cooling method, which dictates the type of condenser used, should be decided based on the expected solvent load. More vigorous cooling is demanded for high volumes, rapid distillation, and very low-boiling solvents.

## RECENTLY RELEASED EVAPORATORS

### Rocket

- Evaporates samples quickly and with a precise temperature control
- Dries or concentrates as many as six large volume flasks or 18 ASE tubes simultaneously
- Provides excellent recoveries of even the most volatile analytes
- Dri-Pure® technology prevents solvent bumping and cross contamination inherent with rotary evaporator and other vacuum evaporation systems



Genevac

[www.genevac.com](http://www.genevac.com)

### RapidVap Vertex

- Microprocessor-controlled heater supplies heat to the block and is programmable from 30° C to 100° C in 1 degree increments
- Up to 50 samples may be processed at once for maximum throughput
- Nitrogen blow down reduces the partial pressure directly over the liquid to speed evaporation and helps remove the solvent as it evaporates



Labconco

[www.labconco.com](http://www.labconco.com)

### Centrifan PE

- Simple, robust and safe for users and samples
- Easy-to-use and low cost of operation
- Less expensive than typical vacuum concentrators
- Replaces polluting nitrogen blow-down set-ups
- Dries six 20 mL vials at once



Modular SFC

[www.modularsfc.com](http://www.modularsfc.com)

### MiniVap™

- Removes volatile organic solvents from HPLC fractions collected in 24- or 96-well microplates
- Installation just requires connection to a standard gas supply and standard mains socket
- Incorporates advanced evaporator head technology which directly injects heated nitrogen into each microplate well simultaneously



Porvair Sciences  
[www.porvair-sciences.com](http://www.porvair-sciences.com)

## EVAPORATOR MANUFACTURERS

Buchi

[www.buchi.com](http://www.buchi.com)

EYELA

[www.eyelausa.com](http://www.eyelausa.com)

Fisher Scientific

[www.fishersci.com](http://www.fishersci.com)

Genevac

[www.genevac.com](http://www.genevac.com)

Glas-Col

[www.glascol.com](http://www.glascol.com)

Heidolph USA

[www.heidolphUSA.com](http://www.heidolphUSA.com)

IKA Works

[www.ika.net](http://www.ika.net)

JEOL USA

[www.jeolusa.com](http://www.jeolusa.com)

Labconco

[www.labconco.com](http://www.labconco.com)

Modular SFC

[www.modularsfc.com](http://www.modularsfc.com)

Organomation Associates

[www.organomation.com](http://www.organomation.com)

Pope Scientific

[www.popeinc.com](http://www.popeinc.com)

Porvair Sciences

[www.porvair-sciences.com](http://www.porvair-sciences.com)

VACUUBRAND

[www.vacuubrand.com](http://www.vacuubrand.com)

Yamato Scientific America

[www.yamato-usa.com](http://www.yamato-usa.com)



# INNOVATION AT HIGH, LOW ENDS OF INSTRUMENT SPECTRUM

In response to reduced reliance on core lab services, manufacturers of flow cytometers have been busily upgrading instrument capabilities for expert and casual users. We have seen this trend before, notably in high-priced instruments like nuclear magnetic resonance and mass spectrometers.

Toward this end, BD Biosciences (San Jose, CA) has launched a noncore four-laser cell analyzer that detects up to 18 colors, as well as a seven-laser cell sorter that paves the way for six-way sorting (for six distinct cell populations) in core labs. Similarly, BD has created an upgrade path for its Aria line of cell sorters, from three or four lasers to six or more.

**“Users should be able to operate a two-laser system within a few hours of opening the box; more-complex instruments may require a three-to-four-day training course.”**

“This means that users who are experienced users can experience higher throughput and get more information out of their experiments,” notes J. Clark Mason, Ph.D., BD’s senior director for research instrumentation.

For Dr. Mason, the distinguishing characteristic of core lab vs. individual group instruments is not so much size as capability or instrument complexity. It all comes down to economics and usage. If an instrument

will not be used around the clock, in general makes more sense to install a half-million-dollar flow cytometer as a core instrument. “Flow cytometers with five- to seven-laser capability are almost always found in core labs, where the workflows justify the capital equipment cost. Research labs tend to operate more economically.”

Like Dr. Mason, Accuri Cytometers (Ann Arbor, MI) believes manufacturers must simultaneously serve the needs for complex, multicolor analysis and what VP of Marketing Grant Howes calls “bread and butter analysis with four colors or less, which constitutes the vast majority of current work.” Instruments and methods

serving the latter market need to be easy to learn, use, and teach; be highly reliable; and have a low cost of ownership across the lifecycle.

“Miniaturization and standardization have become critical for reaching these less sophisticated users,” Mr. Howes says.

Labs that do not require the high level of sophistication of five-, six-, and seven-laser instruments benefit from running sorting or counting experiments

themselves: Results are obtained in minutes vs. hours or days, and personnel acquire hands-on experience with flow methods. Facilities gain as well, since core instrument operators, who tend to be experts, are now free to pursue data analysis and other “brain” work.

When scouting an FC purchase, buyers should seek the “best fit for function,” Mr. Howes says.

Users running simple assays involving cell viability or counting often don’t require a high level of sophistication. “These purchasers should balance ease of setup, of running samples, and [of] acquiring/analyzing data against cost of use and investment in learning to use the instrument.”

Users should be able to operate a two-laser system within a few hours of opening the box; more-complex instruments may require a three-to-four-day training course.

Data features are critical: For example, must the instrument be networked? Need it be compatible with third-party data storage or analysis applications?

Finally, Dr. Mason of BD encourages potential buyers to analyze their current and future cytometry needs based on their technical expertise and to budget accordingly.

## RECENTLY RELEASED FLOW CYTOMETERS

### BD Accuri® C6

- Easy to use, simple to maintain, and affordable
- Equipped with a blue and a red laser, two light scatter detectors, and four fluorescence detectors with optical filters optimized for the detection of fluorochromes
- BD Accuri CFlow® software Zoom function allows visualization of data at any scale
- Tested to ensure the design can withstand rugged conditions



BD Biosciences

[www.bdbiosciences.com](http://www.bdbiosciences.com)

### Attune® Acoustic Focusing Cytometer

- New laser configuration (blue/red) enables users to perform a wider range of research applications, including rare-event detection and environmental studies
- Sensitivity of the instrument facilitates analysis of precious, difficult-to-acquire samples
- Allows quick acquisition of diluted samples and simplified workflow with a no-lyse, no-wash, no cell loss method for sample preparation



Life Technologies

[www.lifetech.com](http://www.lifetech.com)

### Flow Cytometry Analysis Software

#### Kaluza 1.1

- Processes multicolor files of up to 10 million events in real time
- The NVIDIA Tesla Supercomputer option allows for even faster data processing
- Analyzes data from various platforms, such as MoFlo Series sorters, CyAn ADP and Gallios flow cytometry analyzers, and systems such as iCys and iCyt automated imaging cytometers

Beckman Coulter

[www.beckmancoulter.com](http://www.beckmancoulter.com)

### CyFlow® Cube 6

- Includes 1 or 2 Lasers, 6 Optical Parameters - 4 Colors
- Features high-performance, bench-top design
- Also includes built-in PC and two built-in 15.4" TFT monitors
- Choice of 488, 638, 407, 355, 375, 532, 561, 594, 785 nm lasers
- Optional high power 365 nm UV LED for highest resolution DNA analysis with CV ≤ 1%



Partec

[www.partec.com](http://www.partec.com)

## FLOW CYTOMETER MANUFACTURERS

BD Biosciences

[www.bdbiosciences.com](http://www.bdbiosciences.com)

Beckman Coulter

[www.beckmancoulter.com](http://www.beckmancoulter.com)

Life Technologies

[www.lifetech.com](http://www.lifetech.com)

Partec

[www.partec.com](http://www.partec.com)

# ADVANCED CONTROL TOPS RICH FEATURE OPTIONS

Demand for reliable methods of preparing and storing high-value samples has rejuvenated the market for freeze-dryers, also known as lyophilizers. In response, vendors have transformed freeze-dryers from clunky, homemade ag-

slowly be ruined by units with coils that cannot handle the volume of sublimate.

Freeze-drying requires close control over freezing rate, drying temperature, and pressure in order to prevent product melt-back, which

Technology (Kingston, NY). Millrock has championed a technique, Auto-Dry, to assist in achieving rapid optimization.

Auto-Dry generates a baseline protocol based upon user input. It consists of a software algorithm and a PLC (programmable logic controller) that can replace the existing controller.

Once the baseline protocol is established, the freeze-dryer automatically adjusts the shelf temperature to minimize freeze-drying time while keeping the product well below its critical temperature.

Auto-Dry automatically detects the end of primary drying and advances to secondary drying using either a conservative or an aggressive profile.

With conventional freeze-drying, the operator needs to monitor product temperature and manually adjust shelf temperature over the entire course of the lyophilization. The result is typically a long, conservative cycle. "Reducing lyophilization time is critical for keeping operating costs to a minimum," Mr. Thompson notes.

Lastly, when considering the purchase of a freeze-dryer all but the most experienced users should consult with an expert to determine which configuration and features best fit the user's needs.

**"One of the most significant trends in freeze-drying instrumentation has been the integration of lyophilization's three steps."**

glomerations of pumps, flasks, and cold traps to precision instruments under strict computer control. Freeze-drying removes close to 100 percent of the water from a sample, leaving behind either the structural framework of plant or animal tissues or powdery chemicals, proteins, or residues.

One of the most significant trends in freeze-drying instrumentation has been the integration of lyophilization's three steps (freezing, primary drying, and secondary drying) into a single, miniaturized instrument.

Freeze-drying is hard on vacuum pumps, which is why Labconco includes a moisture detector in the drain lines of some units. The sensor prevents the pump from turning on in the presence of significant moisture. "The last thing you want is to ruin your pump by having it suck in a liter of melted ice," says Labconco product manager Jenny Sprung. Pumps can also

occurs when the product temperature rises above its critical point.

Product temperature is controlled by adjusting the shelf temperature. It may still vary significantly, however, depending on its thickness, the solids content, the thickness of the dry layer during primary drying, and the equipment's condensing rate and heat transfer dynamics.

Historically, drying temperature is adjusted by trial and error until a suitable freeze-drying process is established for a particular quantity of a specific product. Subsequent runs are conducted according to that protocol, without in-process temperature monitoring.

This empirical approach requires numerous trial runs, which may be unreasonable to perform at scale with very high-value products. "So the goal should be to achieve an acceptable freeze-drying protocol in a single test run," says T.N. Thompson, president of Millrock

## RECENTLY RELEASED FREEZE DRYERS

### FDU-1200

- Features trap cooling temperature of up to -45°C
- Ice holding capacity is 1L/time
- Safety features include: automatic operation for vacuum pump, monitoring for vacuum degree and trap temperature, stop watch, selecting the setting for power recovery
- Includes sheet key type, digital display

EYELA USA  
www.eyelausa.com



### Benchtop™ K Series Manifold

- Ease of use is ensured by one button start-up that activates all operating parameters in the correct sequence
- Employ environmentally friendly CFC-free refrigeration systems
- Condenser temperatures from range -55°C to -105°C
- Equipped with the Sentry 2.0 user-friendly control system

SP Scientific  
www.spscientific.com



### FreeZone

- Include ice holding capacity for light to moderate loads and have dual refrigeration systems for samples with very low eutectic points
- Provide a compact benchtop design and include a 12-port drying chamber
- -105°C 4.5 liter systems remove over 4 liters of water in 24 hours

Labconco  
www.labconco.com



### Freeze Dryer w/ concentrator

- Works well for samples with solvent
- Prevents bubbling of a sample within the tube by a strong centrifugal force; permits 100% recovery
- "Concentrator" can concentrate & dry using various capacity tubes from 1.5 ml micro-tubes to 50 ml tube

Z-Sciences  
www.z-sciences.com



## FREEZE DRYER MANUFACTURERS

EYELA

www.eyelausa.com

Labconco

www.labconco.com

SP Scientific

www.spscientific.com

Z-sciences

www.z-sciences.com



# DUCTLESS MODELS AT FOREFRONT OF “GREEN” LAB MOVEMENT

Fume hoods are notorious for consuming expensive resources, particularly electricity and conditioned air that is vented to the environment along with volatile chemicals and other toxins.

A decade ago, low-flow hoods revolutionized the industry by reducing air throughput and related energy costs by 40 percent. According to Jon Zboralski, director of air flow products at Thermo Fisher Scientific (Two Rivers, WI), the industry still considers low-flow hoods “new” despite their ten years on the market and hard evidence they can save facilities as much as \$2,400 per year per hood.

More recently, ductless hoods changed the equation yet again in favor of greater energy efficiency and cost savings.

Ductless fume hoods use activated carbon filters to remove toxins from the airstream. Unlike traditional hoods, which vent tens of thousands of cubic feet of heated or air-conditioned workspace per day, ductless fume hoods return conditioned air to the lab. “This translates to a significant drop in energy use,” observes Kevin McGough, president of AirClean Systems (Raleigh, NC).

Equipment longevity also plays into the idea of a “green” laboratory. Although fume hoods do not “wear out” like other laboratory fixtures,

they have a finite usable life. Customers, according to Mr. McGough, pay close attention to quality, materials of construction, and anticipated product lifecycle. In response, fume hood manufacturers have embraced the use of polypropylene, a specialty of AirClean. Compared with metal, polypropylene offers advantages of corrosion resistance and seamless/gapless construction.

AirClean customers have been requesting mobile fume hoods to accommodate expanding or changing workflows and to avoid costly construction costs associated with

**“Ductless fume hoods use activated carbon filters to remove toxins from the airstream.”**

vented hoods. “Ductless solutions are key here,” Mr. McGough says, “as they need not be connected to the facility’s HVAC system and may be moved from one work area to another in minutes. The only requirements are an electrical outlet and at least six inches of clearance from the ceiling.”

Traditionalists may recoil from the idea that chemical-laden air can be cleaned and returned to the work area. Manufacturers are quite aware of this and have bent over backward

to demonstrate that ductless technologies are safe and work as advertised.

A ductless fume hood requires no ductwork, arrives fully assembled, and may be installed in locations where, barring a significant and expensive renovation process, a traditional fume hood could not.

At the time of their introduction, ductless hoods were limited by their filtration systems, which tended to be application-specific. “If you used formaldehyde, you needed a filter specifically designed for removing formaldehyde,” says Mr. McGough.

That is changing rapidly with the 2009 debut, from ErLab (Rowley, MA), of Neutradine molecular filtration, a type of super-activated carbon that is nearly a universal chemical absorber. Neutradine incorporates binding sites for various chemical families, and neutralizes acids as well. Inde-

pendent tests have demonstrated this filtration medium removes 98 percent of all chemical fumes used by 99.9 percent of laboratories. ErLab has partnered with Thermo, Airmaster, and ALC Collegedale to supply Neutradine media for ductless hoods.

## AirClean® Systems’ Independence™ Ductless Fume Hood

As research and laboratories evolve, AirClean® Systems continues to innovate with sophisticated, efficient fume containment solutions. Independence™ is the culmination of two decades of research and development in airflow design, gas-phase filtration, fume detection and hood control technologies. Drawing on feedback from thousands of customer applications, the Independence™ fume hood incorporates unique features not currently incorporated into other fume hoods.

AirSafe™ TOUCH, the first touch-screen microprocessor controller with software written exclusively for use with ductless fume hoods, serves as the technology backbone for many features debuted by Independence™. An engaging, user-friendly interface, AirSafe™ TOUCH allows the user to quickly access all controls while providing displays of vital data such as fume hood face velocity, gas levels and alarm status.

Moving beyond the industry-standard metal oxide sensor, a PID (photo ionization detector) monitors the system’s gas-phase filtration, providing gas saturation readings in parts-per-million. The filtration bed, fume hood exhaust and laboratory air are all monitored by the PID. User-defined alarms can be enabled for each sensor and monitoring location, ensuring the user is notified of any potential exposure.

Carbon-based filtration, as found in most ductless fume hoods, has been in use for centuries. With the invention of Silconazyme™, AirClean® Systems has improved upon carbon filters by increasing the adsorption capability on a wider spectrum of commonly manipulated laboratory chemicals. Silconazyme™ has an improved efficacy for capture of polar organic solvents, nonpolar organic solvents, inorganic bases and inorganic acids.

Filtered air is recirculated by ductless hoods, making it imperative that the filtration be capable of capturing chemicals used within the hood. Built into the Independence™ software is a chemical reference library containing more than 1,000 chemicals approved for use with Silconazyme™. During factory QA/QC, the approved chemical application is programmed into Independence™. In the event another chemical is to be added, the administrator

can update the approved application through AirSafe™ TOUCH. The system then validates the new application against the installed filters and gas detection package to confirm compatibility.

For years, fume hoods have been seen as the laboratory’s biggest consumer of energy. Ductless hoods such as Independence™ recirculate clean, filtered air, limiting the amount of energy spent removing and reconditioning air within the laboratory. To further reduce energy use, lack of operator interaction activates the Independence™ ‘standby mode’. Once in standby mode, energy consumption is reduced to a minimum while maintaining operator safety.

Independence™ provides three methods of airflow monitoring and control. The most popular is automatic mode, where a user preset value is entered into the microprocessor and face velocity is maintained automatically during the course of operation. Manual mode allows the end user to increase or decrease blower speed at their discretion while high/low mode sets the blower to one of two speeds based on sash position.

For labs with multiple hood users, Independence™ includes the ability to have eight unique user profiles with definable operation perimeters for each. At the owner’s or administrator’s discretion, an individual user can be given access to certain features. Examples of definable user access include enabling burning gas, modifying alarm settings, and changing blower modes.

Engineered as a platform capable of evolving as technology and market demands change, Independence™ is the foundation for all future ductless fume hood solutions.

**AirClean® Systems**  
The Fume Control Experts.

Raleigh, NC USA  
919-255-3220 • 800-849-0472  
info@aircleansystems.com  
www.aircleansystems.com



## RECENTLY RELEASED FUME HOODS

### Independence Ductless

- Provides a new onboard chemical database with over 1,000 approved chemicals
- Built-in gas analyzer can give absolute exhaust and Interfilter values in ppm
- Allows for one gas filter that fits most gas phase applications
- Features AirClean Operating System written exclusively for fume hoods
- Combines 'true zero' gas measurement with multiple gas detection methods



AirClean Systems

[www.aircleansystems.com](http://www.aircleansystems.com)

### Purair 20 Ductless

- A face velocity at 100 fpm ensures containment of fumes and an alarm will alert the operator when the airflow falls to an unacceptable level
- All mechanisms in the head section are on the clean side of the filter, preventing contamination
- 49" wide by 27.5" deep by 47.5" high. Other sizes are available up to 96" wide.



Air Science USA

[www.airscience.com](http://www.airscience.com)

### SE Aire-Stream

- UL 1805 certified and offered in 48", 60", 72" and 96" widths in either constant air volume or restricted bypass models
- Features molded one piece seamless white surface and all corners coved for easy cleaning and light reflectivity
- Maximizes user protection and energy savings



HEMCO

[www.hemcocorp.com](http://www.hemcocorp.com)

### Protector® XStream®

- Performs well at low air volumes
- Operating the unit at OSHA-approved 60 fpm provides significant energy savings compared to operating a traditional hood at 80 or 100 fpm
- Has patented features that work together to significantly reduce the concentrations of contaminants in areas behind the sash opening and near the user's breathing zone



Labconco

[www.labconco.com](http://www.labconco.com)

## FUME HOOD MANUFACTURERS

<b>Air Master Systems</b>	<a href="http://www.airmastersystems.com">www.airmastersystems.com</a>
<b>Air Science</b>	<a href="http://www.air-science.com">www.air-science.com</a>
<b>AirClean Systems</b>	<a href="http://www.aircleansystems.com">www.aircleansystems.com</a>
<b>Bedcolab Ltd.</b>	<a href="http://www.bedcolab.com">www.bedcolab.com</a>
<b>CIF Furniture Ltd.</b>	<a href="http://www.cifsolutions.com">www.cifsolutions.com</a>
<b>CLEATECH</b>	<a href="http://www.cleatech.com">www.cleatech.com</a>
<b>Design Filtration</b>	<a href="http://www.designfiltration.com">www.designfiltration.com</a>
<b>Erlab</b>	<a href="http://www.greenfumehood.com">www.greenfumehood.com</a>
<b>ESCO</b>	<a href="http://www.escoglobal.com">www.escoglobal.com</a>
<b>Flow Sciences</b>	<a href="http://www.flowsciences.com">www.flowsciences.com</a>
<b>Genie Scientific</b>	<a href="http://www.geniescientific.com">www.geniescientific.com</a>
<b>Germfree Laboratories</b>	<a href="http://www.germfree.com">www.germfree.com</a>
<b>Hanson Lab Furniture</b>	<a href="http://www.hansonlab.com">www.hansonlab.com</a>
<b>HEMCO</b>	<a href="http://www.hemcocorp.com">www.hemcocorp.com</a>
<b>ISEC</b>	<a href="http://www.isecinc.com">www.isecinc.com</a>

<b>Lab Synergy</b>	<a href="http://www.labsynergy.com">www.labsynergy.com</a>
<b>Labconco</b>	<a href="http://www.labconco.com">www.labconco.com</a>
<b>LM Air Technology</b>	<a href="http://www.lmairtech.com">www.lmairtech.com</a>
<b>Misonix</b>	<a href="http://www.misonix.com">www.misonix.com</a>
<b>Mott Manufacturing</b>	<a href="http://www.mott.ca">www.mott.ca</a>
<b>mottLAB</b>	<a href="http://www.mottlab.com">www.mottlab.com</a>
<b>NuAire</b>	<a href="http://www.nuaire.com">www.nuaire.com</a>
<b>RDM Industrial Products</b>	<a href="http://www.labspace solutions.com">www.labspace solutions.com</a>
<b>Salare</b>	<a href="http://www.salareinc.com">www.salareinc.com</a>
<b>Sentry Air Systems</b>	<a href="http://www.sentryair.com">www.sentryair.com</a>
<b>Terra Universal</b>	<a href="http://www.terrauniversal.com">www.terrauniversal.com</a>
<b>TFI/Inline Design</b>	<a href="http://www.tfiinlinedesign.net">www.tfiinlinedesign.net</a>
<b>The Baker Company</b>	<a href="http://www.bakerco.com">www.bakerco.com</a>
<b>Thermo Fisher Scientific</b>	<a href="http://www.thermo.com">www.thermo.com</a>
<b>Z-sciences</b>	<a href="http://www.z-sciences.com">www.z-sciences.com</a>

## Captair® Flex™— Ductless Mobile Fume Hoods with Modular Filtration Column

From the people who brought you the energy saving GreenFumeHood®, ERLAB, the one and only inventor of the ductless filtering fume hood and worldwide leader since 1968 innovates once again with the low cost Captair® Flex™ Technology, an all in one filtration fume hood design configurable at will for use in chemistry, biochemistry, pharmacology, forensics, histology/pathology and more. New modular filtration column can handle liquids and powders individually or at the same time. Innovative liquid seal technology insures filtration integrity for both molecular and HEPA filters. Unique design allows for single or double back-up safety filtration to comply with the AFNOR NFX 15-211 Class I and II safety standard.



388 Newburyport Turnpike  
Rowley, MA 01969  
1-800-964-4434  
[www.captair.com](http://www.captair.com)

### Fume Hood Safety & Flexibility – Like never before

Captair solutions are designed with safety in mind. The Captair Flex filtration technology is based on the proven principal of molecular adsorption; the toxins emitted in the workstation are adsorbed by the activated carbon within the filtration column and captured – keeping the user and the environment safe.

The Flex also has a unique modular filtration design which allows the hood to handle liquids and powders individually or at the same time. This interchangeability of the filters allows the filtration column to be configured specifically for the applications carried out within the enclosure.

The containment and filtration effectiveness of the Captair Flex, make this shared protective equipment a reliable, economical, flexible and environmentally-friendly solution.

### The Captair Flex can:

#### 1) Save on energy costs in your lab

The air balance necessary to run ducted systems results in high energy consumption. A Captair solution eliminates the energy costs related to systems for extracting and supplying conditioned air. It is able to keep operating costs low, even when the cost related to filter replacement is taken into account.

#### 2) Eliminate installation costs associated with fume hoods

Implementing a Captair Flex is simple and quick. It does not involve the installation of a

ventilation system for air supply and extraction as required by ducted systems. A single electrical outlet is all you need to run the Captair® Flex® fume hood. It can be installed at any time, without complex planning.

#### 3) Easily transport and instantly use your fume hood

Captair solutions may be moved from one location to another within the same laboratory according to protection needs. They can be easily relocated without affecting the air balance of the equipment

#### 4) Protect the environment

Free of any ducted airflow system, Captair solutions eliminate the direct emission of pollutants into the atmosphere and help to protect the environment. They also avoid the pollution generated as a result of the energy needed to run the airflow systems of traditional ducted fume hoods.



▲ Captair Flex, designed to protect the user, the environment and your budget.





# ISOLATION OR CONTAINMENT WITHOUT CLASSIFIED SPACE

Glove boxes are enclosed, controlled environment chambers that serve as isolation or containment spaces for laboratory work. Most glove boxes operate in isolation mode, under positive pressure, to protect samples or experiments from the environment. More costly containment boxes shield operators from the process.

**“Glove boxes tend to stay cleaner than simpler tissue culture hoods, but when they become contaminated, they are harder to clean.”**

Glove boxes are common in biology labs, but Brian Coy, director of marketing at Coy Laboratory Products (Grass Lake, MI), says demand from the biofuels industry has been brisk with renewed interest in alternative energy. Biofuel projects begin with anaerobic bacteria – grown in controlled environment boxes and assayed for their ability to break down organic matter and produce hydrocarbon fuels under nitrogen atmosphere. “This uptick in demand was not due to any technologic breakthrough; it was purely a result of new funding,” Mr. Coy notes.

Mike Buckwalter, publications director at Terra Universal (Fullerton, CA), cautions buyers to be aware of the differences between containment and

isolation. “They are not interchangeable,” he says. In the glove box marketplace, Terra’s strength has traditionally been isolation units. But the company has received orders for sophisticated containment boxes as well.

Containment is significantly more expensive than isolation for several reasons. For most isolation applications, where the object under study

is not pathogenic, leakage from the box to the lab occurs without dire consequences. In the case of the TB application, a leak could sicken or kill operators. Isolation systems also require a strategy to vent the airborne contents of the glove box to house exhaust in case of emergency.

Sophisticated containment systems often employ PLC (programmable logic control) systems for automating glove box operation. Many also sport graphical human-machine interfaces that list pressure, humidity, and gas composition and depict which valves are open and closed. “Containment involves a lot of valve actuation, pressure monitoring, and airflow management to assure safe conditions,” adds Mr. Buckwalter.

Glove box sterilization is critical for most applications involving organisms, whether pathogenic or not. Glove boxes tend to stay cleaner than simpler tissue culture hoods, but when they become contaminated, they are harder to clean.

Periodic sterilization prevents the viral and bacterial contamination of cell cultures and animal subjects and reduces the likelihood of subsequent infection or cross-contamination in the case of infectious agents.

Hydrogen peroxide vapor is the most efficient way to sterilize a glove box, as the gas penetrates into every corner of the unit. However, the process requires hard-plumbing a gas tank to the side of the glove box, and the gas cylinder must be replaced periodically.

Peroxide is highly caustic, which is bad news for rubber seals and gaskets inside the glove box, and especially dangerous for operators. For these reasons, buyers who desire sterilization are increasingly specifying ultraviolet-C (UV-C) disinfection. UV-C is a short-wavelength irradiation that includes the germicidal 253.7 nm wavelength. UV-C is also hard on rubbers and plastics, but since many materials, including glass, are suitable UV shields, irradiation poses no threat to operators. However, UV disinfection is a line-of-sight technique that only disinfects illuminated areas.

## RECENTLY RELEASED GLOVE BOXES

### Captair Pyramid

- Assembled in a few seconds, the Pyramid can be used anywhere
- Slanted shape of the enclosure provides an ergonomic working position for the user
- Light, mobile and disposable, it is an ideal protection tool which can suit many requirements in the laboratory or in the field
- Each Pyramid is factory-tested to ensure an air-tight seal



Erlab

[www.erlab.com](http://www.erlab.com)

### Protector®

- No detectable leaks greater than 1 x 10<sup>-6</sup> ml/sec
- Filtered Glove Boxes provide inlet and outlet 99.99% efficient HEPA or 99.999% efficient ULPA filtration and a leak-tight physical barrier to protect the operator
- Controlled Atmosphere Glove Boxes exceed Class 1 atmosphere containment conditions for oxygen permeation <1.67 ppm/min



Labconco

[www.Labconco.com](http://www.Labconco.com)

### PureLab Acrylic Series

- Provide a reliable yet economical way to conduct air sensitive reactions under inert conditions
- Can be built to order or chosen from standard configurations
- Customers also have choice of other materials of construction to meet their chemical compatibility needs



Innovative Technology

[www.gloveboxes.com](http://www.gloveboxes.com)

### BacBASiC Anaerobic Work Station

- Features “ally designed” arm ports for maximum reach and comfort
- Includes a removable shield for easy introduction of equipment, cleaning and maintenance
- Features a rapid Auto-Purge Pass Box for introducing Petri plates, specimens and supplies (purge time is less than 50 seconds)



SHEL LAB

[www.shellab.com](http://www.shellab.com)

## GLOVE BOX MANUFACTURERS

Banthrax	<a href="http://www.banthrax.com">www.banthrax.com</a>
Coy Labs	<a href="http://www.coylab.com">www.coylab.com</a>
Erlab	<a href="http://www.erlab.com">www.erlab.com</a>
Germfree	<a href="http://www.germfree.com">www.germfree.com</a>
Innovative Technology	<a href="http://www.gloveboxes.com">www.gloveboxes.com</a>
Labconco	<a href="http://www.labconco.com">www.labconco.com</a>
mBraun	<a href="http://www.mbraunusa.com">www.mbraunusa.com</a>
NuAire	<a href="http://www.nuaire.com">www.nuaire.com</a>
Plas-Labs	<a href="http://www.Plas-Labs.com">www.Plas-Labs.com</a>
SHEL LAB	<a href="http://www.shellab.com">www.shellab.com</a>

# MULTITUDE OF METHODS FOR EXTRACTION FROM NON-LIQUID SAMPLES

Homogenization seeks to create samples in which analytes of interest are dispersed uniformly throughout. Numerous technologies can achieve this, including pressure, mechanical (rotorstator or blade-type), and bead-beating.

Mechanical homogenization is based principally on mechanical shear and the disruption of structures that include tissues from plants, animals, or humans. This mechanical breakdown is assisted to some degree by cavitational forces. Regardless, the operational variables for mechanical homogenization are time, rotor speed, and rotor type.

Ultrasonic homogenizers rely exclusively on cavitation, a phenomenon that has drawn a lot of attention for chemical synthesis. Cavitation involves sound waves traveling through fluids that create microscopic bubbles that expand and then collapse violently, attacking and disrupting nearby cells and structures.

Mechanical homogenizers have a reputation for breaking samples down to nanometer-sized particles, and this is certainly true for long, high-speed runs. But as Holly Yacko Archibald – sales director at PRO Scientific (Oxford, CT) – notes, breakdown into almost any particle size domain is possible. “It’s possible to gently mix samples by running for a few seconds at low speed, which will provide a broader particle size bandwidth.”

Another misconception involves the alleged inability to process very small sample sizes, an important consideration as samples become more valuable. Mechanical probes have no problem processing samples even in 0.5 mL tubes, assures Ms. Archibald.

Since mechanical homogenizers resemble kitchen blenders, some cost-conscious lab managers assume that a \$12 appliance will perform as well as a homogenizer. While that may be true for some easily processed samples for which precision and reproducibility are nonissues, dedicated homogenizers hold several trumps over blenders.

Mechanical homogenizers use precision-crafted stainless steel rotors and probes that are easy to clean, chemically resistant, and autoclavable. “And their results are reproducible,” Ms. Archibald adds.

Some instruments incorporate both ultrasonic and mechanical homogenization modes.

The main advantage of dual-mode homogenization is the ability to reach submicron particle sizes rapidly and reproducibly while mitigating somewhat the drawbacks of both modes. Mechanical and ultrasonic homogenization occur sequentially: First, mechanical disruption handles the larger-sized particles, then the ultrasonic probe turns on to complete the process. Alternatively, users

may use either mode alone.

Since ultrasound tends to heat samples through cavitation effects, it’s not always suitable for heat-sensitive samples. Dual-mode homogenization minimizes sample contact with ultrasound, thereby sparing labile analytes from long exposure to ultrasound.

“Users should consider what they are trying to homogenize, and how small they need their samples to be,” says Tracy Christian, marketing coordinator at IKA Works (Wilmington, NC). Achieving submicron particle sizes involves either ultrasonic disruption or bead milling. The former is faster but is noisy, tends to heat the sample, and can sometimes alter its chemical characteristics.

According to Ms. Christian, other desirables include:

- easy cleaning of product-contact surfaces
- a low motor noise, since homogenizers are usually located on workbenches close to operators
- ease of use
- rapid homogenization
- user control over homogenization parameters through a familiar digital display
- low heat generation
- a programmable library of methods

## RECENTLY RELEASED HOMOGENIZERS

### Omni Bead Ruptor 24

- Simultaneously homogenizes in either 24 x 2mL or 12 x 7mL tubes
- Whisper Drive Technology delivers ultra-quiet motor operation
- No cool-down required between processes: Processes hundreds of samples per day
- 99 programmable memory settings
- Disposable tubes ensure no threat of cross-contamination or sample degradation



Omni  
[www.omni-inc.com](http://www.omni-inc.com)

### IKA T 25 Digital

- For volumes of 1 to 2,000 ml (H2O)
- Rotor-stator process has delivered proven results for 30 years
- Multiple stainless steel dispersing elements are available with a variety of rotor/stator configurations for a wide range of applications or disposable plastic dispersing tools
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### KINEMATICA POLYTRON® PT 10-35GT

- LED speed indication for better reproducibility
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BioSpec	<a href="http://www.biospec.com">www.biospec.com</a>	Omni	<a href="http://www.omni-inc.com">www.omni-inc.com</a>
Branson Ultrasonics	<a href="http://www.bransonultrasonics.com">www.bransonultrasonics.com</a>	Precellys	<a href="http://www.precellys.com">www.precellys.com</a>
Glas-Col	<a href="http://www.glas-col.com">www.glas-col.com</a>	PRO Scientific	<a href="http://www.proscientific.com">www.proscientific.com</a>
Hielscher Ultrasonics	<a href="http://www.hielscher.com">www.hielscher.com</a>	QIAGEN	<a href="http://www.qiagen.com">www.qiagen.com</a>
IKA	<a href="http://www.ika.com">www.ika.com</a>	Qsonica	<a href="http://www.sonicator.com">www.sonicator.com</a>
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Microfluidics	<a href="http://www.microfluidicscorp.com">www.microfluidicscorp.com</a>	Sonics & Materials	<a href="http://www.sonics.com">www.sonics.com</a>
Mo Bio Laboratories, Inc.	<a href="http://www.mobio.com">www.mobio.com</a>	Z-sciences	<a href="http://www.z-sciences.com">www.z-sciences.com</a>



# CONNECTING INSTRUMENTS TO THE DATA BACKBONE

Laboratory information management systems (LIMSs) are software packages that connect instruments, other software, and sample management to human operators and other data systems, including electronic laboratory notebooks (ELNs).

Despite their independent developments for different tasks, distinctions between ELNs and LIMSs are not obvious, notes John McCarthy, VP of product management at Accelrys (San Diego, CA). ELNs occupy a supervisory position—a larger lab data management platform—that accesses the activities of LIMSs.

LIMSs tend to be application- or workflow-specific, resulting in different products for chemistry, biology, quality assurance, and related protocols. Notebooks handle a wider range of data and present them in forms that enable collaboration.

Bruce Pharr, VP for products and marketing at GenoLogics (Victoria, BC) adds laboratories are built around two key assets: workers and instruments. “The ELN is for the scientist; the LIMS is for the instrument,” he explains. The control panel for instrumentation serves as the LIMS user interface, whereas the ELN can be viewed as the control panel for the entire laboratory. The LIMS works around a structured data set, tracking samples from the time they enter a lab through the numerical results. ELNs, as replacements for paper notebooks,

handle unstructured data as well.

Nevertheless, the two products are coalescing or converging for some operations such as sample preparation and identification. “If you’re in a lab notebook, you don’t want to have to switch to a LIMS to obtain a sample ID,” Mr. McCarthy says.

Data standards have become a huge focus area for LIMS developers. Standards are needed so that data repositories can communicate, for example, so a LIMS designed for one task can read data from a different LIMS.

Accelrys is working with three large pharmaceutical companies on standard LIMS interfaces based on BatchML (batch markup language) and B2MML (business-to-manufacturing markup language), extensions of XML (extensible markup language). XML is a way to encode documents for machine readability.

**“The ELN is for the scientist; the LIMS is for the instrument,” explains Bruce Pharr, VP for products and marketing at GenoLogics.’**

These capabilities will allow new LIMS deployments to read data directly from legacy LIMSs, without the need to rekey data or transfer it to a word processing document.

In the past, LIMS purchase decisions were made at the laboratory

level. Increasingly, companies select these products on an organization-wide basis. “There’s a pricing benefit, no doubt, but standardization—not having to rekey data—is the driver,” Mr. McCarthy says. LIMS interoperability may also be achieved through the ELN’s supervisory role, as mentioned, by applying an appropriate markup language.

LIMSs fit well with workflows that involve automation and require high reproducibility. GenoLogics’ specialty, for example, is LIMSs for next-generation genomics sequencing. This market is driven by the adoption of next-generation sequencers, which numbered 200 in 2007. Today, more than 1,900 such instruments have been deployed around the world.

GenoLogics has been receiving requests from labs requesting products that work out of the box and do

not need to be specially configured. “These users don’t want custom implementations,” says Mr. Pharr.

Despite this trend, a LIMS may not make sense for many “low event” labs, many of which are comfortable inputting data manually.

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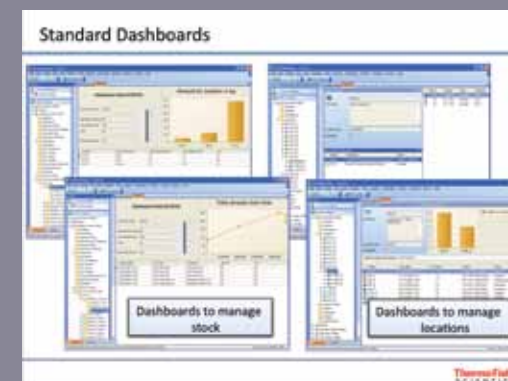
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LIMS MANUFACTURERS

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Aurora Systems	<a href="http://www.visualab.com">www.visualab.com</a>
Autoscribe	<a href="http://www.autoscribelims.com">www.autoscribelims.com</a>
Bruker	<a href="http://www.bruker.com">www.bruker.com</a>
ChemSW	<a href="http://www.chemsw.com">www.chemsw.com</a>
ChemWare	<a href="http://www.chemware.com">www.chemware.com</a>
GenLogics	
Life Sciences Software, Inc.	<a href="http://www.genologics.com">www.genologics.com</a>
H&A Scientific	<a href="http://www.hascientific.com">www.hascientific.com</a>
H&A Scientific	<a href="http://www.hascientific.com">www.hascientific.com</a>
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Novatek International	<a href="http://www.ntint.com">www.ntint.com</a>
ReTiSoft Inc.	<a href="http://www.retisoft.ca">www.retisoft.ca</a>
RURO	<a href="http://www.ruro.com">www.ruro.com</a>
Sapio Sciences	<a href="http://www.sapiosciences.com">www.sapiosciences.com</a>
STARLIMS	<a href="http://www.starlims.com">www.starlims.com</a>
Symyx/Accelrys	<a href="http://www.symyx.com">www.symyx.com</a>
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Chromeleon 7.1 Chromatography Data System Brings Operational Simplicity to the Enterprise



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1214 Oakmead Parkway  
Sunnyvale, CA, 94085, USA  
Phone: +1 408 737 0700

The Thermo Scientific Dionex Chromeleon 7.1, an enterprise-ready version of the innovative Chromeleon 7 chromatography data system launched in 2009, combines intelligent functionality with a new user interface based on Operational Simplicity™, and provides the fastest path from samples to results. The software supports Windows 7® (32/64 bit), Windows Vista®, and Windows XP, and is fully scalable from a single workstation to a global enterprise. Chromeleon software version 7.1 adds support for Dionex Summit HPLCs, ASE™ accelerated solvent extractors, and fluorescence detectors, as well as LCs and GCs from Agilent, Waters, and Shimadzu.

Unique new Interactive Charts instantly reveal patterns in results, and provide dynamic interactive links to chromatograms, spectra, and tables that invite exploration and discovery. A method speed-up wizard generates UHPLC methods from existing HPLC methods, making faster chromatography easily accessible. The 3D Amperometry feature enables study and characterization of non-chromophoric compounds with lower cost and complexity compared to mass spectrometry.

For enterprises, centralized license management, centralized data storage, enhanced network failure protection, easy workstation and network setup, and efficient administration tools all save time, ensure reliable operation, and minimize costs. Compliance tools include System Suitability Testing and Electronic Signatures. Together with detailed Audit Trails and automated validation tools, they make the job of maintaining compliance with GLP and 21 CFR Part 11 easier than ever.





## FREEZERPRO - INTUITIVE SAMPLE MANAGEMENT

At RURO, we strive to develop software that combines user-friendly, web-based interfaces with documentation tools suited to even the most complex scientific information and processes. The FreezerPro platform, now celebrating its 5th anniversary, is no exception to this principal.

# RuRo

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FreezerPro helps scientists in the following ways:

### BETTER ORGANIZATION:

- FreezerPro offers effective flexibility in Storage Management, Reporting, and Data Access configurability.
- Data entered in FreezerPro is organized into virtual freezers, shelves, and boxes, reflecting the actual structure of physical objects.
- Configurable Sample Types and User-Defined Fields empower laboratories to establish their sample information profiles exactly.
- Available Communication, Shipping, and Workflow Modules allow users to document specialized sample operations.

### EXPANDED ACCESSIBILITY:

- Truly web-based user interface increases data accessibility- electronic records can be displayed and worked on in the office, at home or other locations.
- SSL encryption is available to ensure the highest level of information security.

### IMPROVED EFFICIENCY:

- Versatile Search Tools dramatically cut down time required to locate information of interest.
- Visual Label Designer enhances barcode scanning and printing through ease of use.

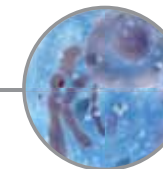
### FREEZERPRO RFID KIT

Thanks to a partnership with industry leaders, RURO is now able to offer RFID (Radio Frequency Identification) hardware in combination with the FreezerPro system. The recently arrived FreezerPro RFID Kit is a complete package that includes all software and hardware needed to bring this exciting technology to any laboratory.

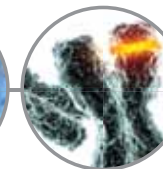


## Fisher Scientific Delivering Workflow Solutions

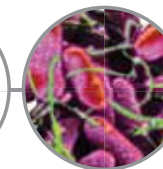
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**RESULTS** is a program built around the concept of laboratory workflow solutions. Fisher Scientific delivers products and services from sample preparation and handling to data collection. Working with trusted brands in the industry, we can provide unparalleled access and technical support to the latest technical innovations to accelerate your search.

# ACHIEVING A DEEP FREEZE

Low-temperature laboratory freezers can achieve temperatures of about -40° C or lower. Kitchen freezers, by contrast, operate to about -20° C. The temperature “sweet spot” for lab freezers is about -85° C. “Mechanical” (compressor-based) freezers reach the -40° to -50° C range with a single compressor. A second compressor is required to cool below that point. To achieve energy efficiency and extend the life of the compressors, the low-stage compressor turns off automatically when the set-point temperature is reached, while the high-stage compressor remains on continuously.

**“High-end freezers should maintain uniform temperature throughout the unit and recover quickly from openings.”**

“Some systems using exotic refrigerants can get much lower than -85° C,” explains Buckner Richerson, VP of international sales at NuAire (Plymouth, MN). For example, ultra-low-temperature freezers reach temperatures of -150° C, which is useful for storing bone marrow for medical procedures. “But these are quite expensive, and not too many are sold,” Richerson said.

Factors to consider when purchasing include communications and data storage, alarms, quality/

configuration of the inner and outer door closures, vacuum release that permits reopening a freezer immediately after door closure, temperature uniformity, and temperature recovery after opening.

Where floor space is at a premium, users can opt for vacuum-insulated panels, which take up less room than polyurethane insulation. Vacuum insulation used to be a rather expensive option, but it has come down in price, Richerson says. Another cold-conserving feature is double outer doors or double inner doors to minimize the loss of cold air.

High-end freezers should maintain uniform temperature

throughout the unit and recover quickly from openings. Opening the door of an ultra-low-temperature freezer introduces warm, moist air that causes the device to work harder to retain its set-point temperature and causes condensation and freezing of water vapor inside the unit. The speed at which a freezer recovers from temperature excursions is a function of BTU reserve capacity, which, according to Thermo Fisher Scientific, is defined as “a measure of a freezer’s ability

to maintain a cold temperature across the entire cabinet in the presence of a heat load.” Higher BTU reserve is better.

Concerns with carbon footprint are spurring innovations in low-temperature refrigeration. Among the trends are alternative cooling mechanisms such as liquid nitrogen, which boils at -196°C. Cryogenic nitrogen is readily available and relatively inexpensive and remains liquid for extended periods, provided its container is insulated. A liquid nitrogen freezer does not use a compressor, and electrical consumption is less than for conventional freezers.

But while the acquisition costs are comparable, ongoing costs for liquid nitrogen are higher than for the electricity it takes to run a mechanical freezer.

Purchasers of low-temperature laboratory freezers can select from numerous options and temperature ranges, but as Chris Wilkes, director of product management for cold storage at Thermo Fisher Scientific (Asheville, NC) notes, “Once you get below -135° C, there is not a huge benefit to getting colder.”

## RECENTLY RELEASED LOW-TEMPERATURE FREEZERS

### UF V Series

- Secures a long-term storage of samples at -86 °C
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- Reduce energy consumption by up to 43% over competition
- Three sizes, two uprights and a chest (14 – 23 cu. ft.)



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### Twin Guard Series™ MDF-U700VXC

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- Features Cool Safe™ refrigeration to extend compressor life and minimize heat output
- EcoMode™ deploys both systems in alternating cycles to maintain -86°C and reduce energy consumption



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## LOW-TEMPERATURE FREEZER MANUFACTURERS

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# BREAKING DOWN CHEMICAL BARRIERS TO METALS ANALYSIS

Microwave digestion is the preparation method of choice for analyzing metals in complex mixtures. Food and environmental industries favor this technique, which is also applicable to testing materials, soil, agricultural waste products, engine oils, and biological samples. Pharmaceutical applications are growing too, as safety-conscious regulators demand trace metal analysis.

Microwaves greatly accelerate the digestion of solid analytes in acid, creating a transparent or clear solution from which all metals are liberated from their matrix. Nitric acid is the digestion medium in organics, but hydrochloric, hydrofluoric, and boric acids may be used in specialized applications. Older methods, which use hot plates or oil baths as a heat source, suffer from slowness, lack of uniformity, and poor control over digestion parameters.

Recently, several vendors have introduced microwave systems that permit loading of multiple samples during each run to improve throughput and to control features.

Today, laboratory microwave systems are used mostly for sample preparation, however, microwave-assisted chemical synthesis is an emerging technique that provides many advantages over conventional heating mantles, oil baths, and hot plates.

Microwaves facilitate the synthesis of organic compounds, organometallics, and even inorganics. During

chemical reactions, microwaves excite molecules in ways that simple heating cannot.

Unlike external heating devices that operate through the sample vessel, microwaves pass through the container and couple directly with the sample matrix, applying energy exactly where it's needed. "And when you turn it off you don't have a large mass to cool down, only the sample," notes Mike Collins, director of strategic marketing at CEM (Matthews, NC).

Microwave sample preparation occurs in high-pressure vessels that reach up to 300° C and 1500 psi. Despite the harsh conditions, equipment has been trending toward simplicity, making its benefits are more accessible.

**"Recently, several vendors have introduced microwave systems that permit loading of multiple samples during each run to improve throughput."**

"Microwave digestion saves a lot of time during sample prep for inorganic analysis," says Joseph A. Caruso, Ph.D., professor of analytical chemistry at the University of Cincinnati (Cincinnati, OH). Dr. Caruso notes that different conditions may be applied to each sample in a multi-sample unit, all under computer control. The CEM model he uses holds up to 96 sample tubes. "You can set the samples up at the end of a work day, set up the computer-controlled

parameters for each tube, come in the next morning, and the digestion is complete," Dr. Caruso says.

Anton Paar's microwave-induced oxygen combustion (MIC), a variation on the microwave-assisted digestion theme, aims to fully liberate metallic analytes by combining sample combustion and digestion. MIC dissolves even tough polymer coatings used in extended-release pills, which the company claims are not fully digested with conventional microwave technology.

"The effectiveness of MIC digestion is clearly illustrated with modern drug products, which are increasingly complex," says Reynhardt Klopper, national sales manager for

microwave products at Anton Paar (Ashland, VA). "Enterically coated drugs are protected by synthetic polymers or biopolymers that are resistant to hydrolysis and oxidation."

MIC uses a closed quartz digestion vessel, a pressurized, high-temperature reflux step, and nitric acid. According to Anton Paar, there is no need for complex matrix-matched calibration standards, as NIST-certified calibration solutions suffice.

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### MAS 24 Autosampler

- For proprietary Monowave 300 microwave synthesis reactor
- Up to 24 vials of various sizes can be queued and processed in three different carousel types
- Features a fail-safe gripper driven by compressed air
- Any Monowave 300 already in use can be easily upgraded for automation with a simple upgrade kit

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### NOVAWAVE Microwave Digestion System

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- Available in two models: stand-alone Model SA and fully automated Model FA

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## MICROWAVE SAMPLE PREP MANUFACTURERS

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Milestone Scientific	<a href="http://www.milestonesci.com">www.milestonesci.com</a>
SCP Science	<a href="http://www.scpscience.com">www.scpscience.com</a>

# TOP-DOWN PARTICLE SIZE REDUCTION

Milling and grinding are ancient techniques that are working their way into high-tech markets.

Kyle James, VP of sales at Retsch USA (Newtown, PA) notes that demand for particle size reduction systems has grown significantly from “alternative” industries. “Demand from the energy sector has been substantial, particularly for processing biomass materials such as wood, refuse, and even garbage,” Mr. James says.

The breadth of life science applications has given rise to fierce competition between homogenization and milling/grinding. Both have utility in this area, but the tug of war between competing methods goes on.

Fatty acid sample preparation

and a dearth of new drug approvals. With chemical innovation lagging, drug developers increasingly turn to novel formulations to improve prospects for both old and new compounds. Nanotechnology—the creation of submicron-sized particles of drugs and ingredients—has played a significant role in these efforts.

Nanoformulated drugs dissolve and enter tissues more easily than large crystals, and may even be used to create oral dosage forms and injectable suspensions. Bill Henry, executive VP at Jet Pulverizer (Moorstown, NJ), notes that ball and jet mills have traditionally been used to reduce particle sizes down to just below 1 micron, normally the

size reduction; the manufacturing processes for five approved drugs already use milling.

Two basic strategies exist for creating submicron-sized drug particles. The “bottom up” approach involves precipitation or chemical synthesis; the “top down” approach uses jet milling, wet ball milling, and HPH.

These methods may be combined; for example, bottom-up plus top-down (precipitation to supra-micron particles followed by milling) or top-down plus top-down (micronization followed by nanonization).

HPH, which produces the finest particles of the three techniques, employs a piston-gap homogenizer in water at room temperature. As drug suspensions pass through a “homogenization gap,” the particles are ripped apart during the collision of two fluid streams as a result of their impact with neighboring particles plus shear and cavitation forces.

Jan Möschwitzer, Ph.D., who heads early pharmaceutical development at Abbott Healthcare Products (Weesp, The Netherlands) suggests that in selecting a particle size reduction technology, drug developers first consider the bioavailability and pharmacokinetic parameters desired for a specific therapeutic. Perhaps equally important is how easily the size reduction method scales to manufacturing.

upper-size domain limit for all things “nanotech.” “That’s the focus for these mills, particularly for electronics and battery applications,” says Mr. Henry. In pharmaceuticals, he adds, milling may be thought of as a “pre-grind,” or precursor to nanoparticle-generating milling processes.

Yet for some pharmaceuticals, the higher end of the nano-size domain might be just what the doctor ordered. Ball milling is being investigated extensively for drug particle

“The breadth of life science applications has given rise to fierce competition between homogenization and milling/grinding.”

from animal or plant cells is usually conducted with a high-speed emulsifier (e.g., the Ultra-Turrax from IKA Works). The technique, according to literature from Spex Sample Prep (Metuchen, NJ), may be unsuitable for high-throughput labs. Until recently, high-throughput, mechanical cell disruption based on grinding employed traditional ball or swing mills adapted to microtiter plate formats.

The pharmaceutical industry has been hit hard by patent expirations

## RECENTLY RELEASED MILLS AND GRINDERS

### EcoMet® 250/300 Pro Grinder-Polisher

- Stores and recalls 32 methods via touch-screen controls
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Buehler

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### IM4000 Hybrid Ion Milling System

- Capable of both cross-section and flat ion milling
- Uses a wide Argon ion beam to irradiate specimens and uses the sputtering effect to polish the surface without stressing it
- Features a high milling rate ion gun with a processing speed of 300  $\mu\text{m/hr}$
- Suitable for various industries, including semiconductors, materials, research and quality control

Hitachi High Technologies America  
[www.hitachi-hitec.com](http://www.hitachi-hitec.com)



### ZM 200 Ultra Centrifugal Mill with New Cyclone

- Features gentle and very rapid size reduction by pre- and fine grinding in one run
- Includes patented cassette system for maximum sample recovery and easy cleaning
- Provides a wide speed range from 6,000 to 18,000 rpm
- Allows comfortable parameter setting via display and ergonomic 1-button operation



Retsch

[www.retsch-us.com](http://www.retsch-us.com)

### 6970 EFM Enclosed Freezer/Mill

- Features a totally enclosed liquid nitrogen (LN) auto-fill system with external loading of sample vials
- Includes a pre-cooling chamber, allowing additional samples to be cooled while the grinding chamber is in operation
- Controlled by a color touch screen interface that can store up to 10 programs for rapid process replication and consistency

SPEX SamplePrep

[www.spexsampleprep.com](http://www.spexsampleprep.com)

## MILL AND GRINDER MANUFACTURERS

Buehler	<a href="http://www.buehler.com">www.buehler.com</a>
Drais	<a href="http://www.draiswerke-inc.com">www.draiswerke-inc.com</a>
Extex Corporation	<a href="http://www.extec.com">www.extec.com</a>
Fritsch	<a href="http://www.fritsch.de/en">www.fritsch.de/en</a>
Gilson	<a href="http://www.globalgilson.com">www.globalgilson.com</a>
Glen Creston	<a href="http://www.glencreston.co.uk">www.glencreston.co.uk</a>
Glen Mills	<a href="http://www.glenmills.com">www.glenmills.com</a>
Hosokawa	<a href="http://www.hmicronpowder.com">www.hmicronpowder.com</a>
Hitachi High Technologies America	<a href="http://www.hitachi-hitec.com">www.hitachi-hitec.com</a>

IKA Works	<a href="http://www.ika.net">www.ika.net</a>
Lab Synergy	<a href="http://www.labsynergy.com">www.labsynergy.com</a>
Retsch	<a href="http://www.retsch-us.com">www.retsch-us.com</a>
SPEX SamplePrep	<a href="http://www.spexcsp.com">www.spexcsp.com</a>
Sturtevant	<a href="http://www.sturtevantinc.com">www.sturtevantinc.com</a>
The Fitzpatrick Co	<a href="http://www.fitzmill.com">www.fitzmill.com</a>
The Jet Pulverizer Co	<a href="http://www.jetpul.com">www.jetpul.com</a>
Union Process	<a href="http://www.unionprocess.com">www.unionprocess.com</a>



# BASIC UTILITIES FOR HEATING, DRYING, PROCESSING

Most laboratory workers view ovens almost as utilities, using them principally for drying glassware and heat-resistant equipment, regenerating desiccants and catalysts, gently heating samples, and curing or preparing materials and composites.

Common laboratory ovens maintain temperatures ranging from just above ambient to about 300° C and are ubiquitous in chemistry, biology, pharmaceutical, forensics, and environmental labs. Units operating at temperatures above 300° C are normally dedicated to specialized applications in physics, engineering, electronics, and materials processing.

Typical lab ovens use four to six cubic feet of space and are located on benchtops or stacked atop another oven; other units may be much larger.

Oven applications are expanding beyond simple drying: chemists use ovens for thin film battery drying and solvent removal; the food industry desiccates samples inside ovens to determine moisture content; electronics and defense labs process integrated circuit boards and other components inside ovens; and there are many more applications.

“Lab ovens have evolved to suit the demanding needs of end users who require even more precise temperature control, heat distribution, and added safety features,” explains David Craig, North America sales manager at Binder (Great River, NY).

Temperature control, precision temperature distribution, and

temperature ramping/programming are desirable features in an oven but not required for common drying applications. High-end ovens control temperature at 27 points inside the box, whereas ASTM standards require only nine-point control. Similarly, temperature control may be as narrow as a fraction of a degree or can span several degrees.

According to Mr. Craig, the single most important consideration for a potential oven purchaser is the type of temperature controller employed. Simple on-off controllers work

“Another emerging trend is increasing demand for high-temperature ovens from engineering and materials processing labs.”

through a thermostat to turn the oven on and off when the temperature is below or above the setpoint temperature, respectively. Proportional controllers are sophisticated versions of on-off controllers that slow heating as the setpoint temperature is reached, thereby preventing the unit from constantly turning on and off.

By far the most sophisticated controller is the PID (proportional integral derivative) controller. PID controllers are highly desirable for applications that demand precise temperature control and uniformity.

PIDs measure the discrepancy between the actual temperature and the setpoint, then calculate how

long to keep the heating element on to reach the setpoint temperature without overshooting it. While PID controllers take a bit longer to bring the oven to the desired setpoint, they do not constantly overshoot the target temperature as less sophisticated controllers do.

Where lab space is at a premium, purchasers should also consider the unit’s size and stackability. But perhaps the most often overlooked features are related to safety, for example, automatic turnoff if the unit overheats.

Konrad Knauss, oven product manager at Thermo Fisher Scientific (Asheville, NC) said other features are gaining in popularity.

“Until recently almost nobody cared about energy efficiency, but today it’s high on the list of desirables,” says Mr. Knauss. “Perhaps not for end users, but definitely for lab supervisors and facility managers.” Another emerging trend is increasing demand for high-temperature ovens from engineering and materials processing labs, he adds.

## RECENTLY RELEASED OVENS

### ED Series

- Allows for routine drying and sterilization applications up to 300 °C
- Fast, even tempering
- Wide temperature range
- Thanks to the gravity convection, thermal processes are highly efficient

BINDER  
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### TR 60 – 1050

- Features forced air circulation and a maximum working temperature of 300°C
- Stainless steel interior chamber is easy to clean and resistant to rust
- Suitable for various applications, including drying, sterilizing and warm storing
- Features consistent temperature uniformity

Nabertherm  
www.nabertherm.com



### Isotherm ® Series

- Provide multiple redundant over-temperature protection systems for maximum sample and user protection
- Feature electrogalvanized steel with white oven-baked epoxy antimicrobial powder-coated finish
- Comprised of a single piece stainless-steel chamber with rounded corners

ESCO  
www.escoglobal.com



### Heratherm

- Provides gentle heating and drying with minimal air turbulence
- Microprocessor controls deliver detailed information on current temperature and set points
- Allows users to set the temperature from 50 to 330 C and store the setting in memory while the oven is off
- Features a visual over temperature alarm and built-in safety backup

Thermo Scientific  
www.thermoscientific.com



## OVEN MANUFACTURERS

Binder	www.binder-world.com
Boekel Scientific	www.boekelsci.com
Carbolite	www.carbolite.us
Cascade TEK	www.cascadetek.com
ESCO	www.escoglobal.com
Jeio Tech	www.jeiotech.com
Labnet International	www.labnetlink.com
LABREPCO	www.labrepco.com
Lucifer Furnaces	www.luciferfurnaces.com
MTI Corporation	www.mtixtl.com
Nabertherm	www.nabertherm.com

SHEL LAB	www.shellab.com
So-Low	www.so-low.com
SP Industries	www.spindustries.com
Stovall Life Science	www.slsience.com
Ted Pella Inc.	www.tedpella.com
Terra Universal	www.terrauniversal.com
Thermo Scientific	www.thermoscientific.com
Wisconsin Oven Dist.	www.memmertbenchlabovens.com
Yamato Scientific America	www.yamato-usa.com
Z-sciences	www.z-sciences.com

# A MAINSTAY OF VARIOUS LABORATORIES

First introduced by Beckman in 1936, pH meters have become a mainstay of academic, industrial, and manufacturing laboratories. pH meters determine the acidity or alkalinity of a solution by measuring the concentration of hydrogen ions;  $H^+$ ; or, more accurately, the hydronium ion;  $H_3O^+$ . pH is defined as the negative log of the hydronium ion concentration.

A pH meter is actually a voltmeter that uses a hydronium ion-selective glass electrode to measure ion concentrations in the vicinity of the probe. Meters tend to be small, about the size of a shoe box. Most are benchtop units, but numerous vendors now sell battery-powered portable meters for field use.

pH meters are used in many industries: chemical, biological, environmental, forensics, consumer products, foods, and many others for which acidity measurements are warranted. A significant application is monitoring titration, a lab method that quantifies the concentration of an analyte in solution. Acid-base titrations measure concentrations of an acidic or alkaline substance. From the quantity of neutralizing species (acid or base) added at the point where pH is 7, or neutral, one can calculate the original concentration of the acid or base in the solution.

Titration is also employed to adjust the pH of products or, in the case of biology, of buffers or standard solutions.

As George Porter, titration product manager at Metrohm (Riverview, FL) notes, most pH meters may be used as solution voltmeters, which greatly expands their utility beyond acidity and alkalinity. Meters can perform salt concentration measurements by noting the dramatic drop in electrical potential when, say, a halide is precipitated with silver ion. "pH is a derived value calculated from a voltage. With salt concentration measurements you're titrating to a set millivolt point," Mr. Porter observes.

Specialized applications include salt concentration in foods, free amines in chemical reagents or preparations, and Karl-Fischer titration for water in nonaqueous media.

Modern automated titrators do an even better job than manual titration, without the possibility of user error, by delivering precise quantities of acid or base. Without

point calibration using two standard pH solutions daily for routine work and before every measurement for sensitive measurements.

William McGlynn, Ph.D., a food scientist at the Oklahoma Cooperative Extension Service, recommends that users base pH meter purchase decisions on the instrument's resolution and accuracy, probe type (detachable or integrated), electrode type (sealed or longer-lived refillable), and auto-calibration with temperature compensation.

Integrated probes are easier to use but more difficult to replace when they wear out or break. Auto-calibration and temperature compensation are desirable features for sensitive protocols that require frequent calibration.

Metrohm's George Porter advises purchasers to consider how the meter is constructed, particularly

**"Because the performance of the hydrogen ion electrode shifts and degrades over time, pH meters must be calibrated regularly."**

accurate pH metering, this application would not be possible.

Because the performance of the hydrogen ion electrode shifts and degrades over time, pH meters must be calibrated regularly. Manufacturers suggest performing a two-

if the circuits are galvanically separated. "You're looking for an isolated signal," he says. Another factor is how the instrument handles data while ease of calibration is also important.

# SEE WHAT EVERYONE IS TALKING ABOUT...

Two Channel, pH/ORP/ISE, EC/TD/NaCl/Resistivity Benchtop Meter

HI 3512

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- HQd system can test ammonia, pH, dissolved oxygen, conductivity, BOD, ORP and sodium
- System automatically recognizes testing parameters, calibration history and method settings



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- ARC sensors can be precalibrated right in the lab, reducing costs associated with installation and downtime



Hamilton  
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### HI 99161N Food and Dairy

- Available with waterproof casing
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- Easy to clean probe resists clogging
- Offers dual button operation
- Delivers 1000 hour battery life with low battery warning



Hanna Instruments  
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### pHASE pH Electrodes

- Provide highly accurate and stable pH measurement changes in dynamic process environments under wide ranging variable temperature conditions
- Available in two designs: the cost-saving, user-friendly sealed design and the Rapid-Renew refillable design, ideal for dirty samples
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Sensorex

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## pH METER MANUFACTURERS

Beckman Coulter	www.beckmancoulter.com
Corning	www.corning.com
Denver	www.denverinstrumentusa.com
Hach	www.hach.com
Hamilton	www.hamiltoncompany.com
Hanna Instruments	www.hannainst.com/usa
Horiba	www.horiba.com
ITT Analytics	www.itt.com
LaMotte	www.lamotte.com

Metrohm	www.metrohmusa.com
Mettler Toledo	www.mt.com
Nova Analytics	www.novaanalytic.com
Oakton	www.4oakton.com
Omega	www.omega.ca
Pulse Instrument	www.pulseinstrument.com
Sartorius	www.sartorius.com
Sensorex	www.sensorex.com
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## METTLER TOLEDO is pleased to announce a new line of bench meters

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METTLER TOLEDO is pleased to announce a new line of bench meters, the SevenCompact™ series. The new mid-range meters are a great leap forward setting new standards for intuitive operation. The meters fulfill analytical requirements in any industry and in a wide range of workplaces. The SevenCompact™ S220 is a multi-language bench meter for pH/ORP/Ion measurements with the Intelligent Sensor Management® (ISM®) technology. Its complement is the SevenCompact™ S230 which is a multi-language bench meter for conductivity/salinity/TDS/resistivity/conductivity ash measurements with ISM® technology. The S220 and S230 are not only universal and reliable; they are the best in their class.

The SevenCompact™ offers more benefits than most mid-range meters. From security to ease of use, METTLER TOLEDO has you covered.

### EFFICIENT

The series combines precise measurement and innovative design. There is an option to perform straightforward calibrations and measurements with a single key press! The SevenCompact™ guarantees precise and reliable measurements each time.

### INTUITIVE

The meters' functionality is designed to maximize productivity. In the normal screen layout, all the pertinent information is available. By switching to the uFocus™ view, you will not be distracted as less information is displayed. The 4.3 inch high-resolution color display has large digits and well-arranged icons.

### SECURITY

The security package allows you to operate your meter with peace of mind. The GLP support functions, such as PIN protection and GLP print-out, leave nothing to coincidence. There are two modes the meters can function in. The first is the Routine Mode in which the deletion of data and changing of the settings is blocked. The other mode is the Expert Mode, which is PIN protected and allows authorized users to enjoy all functions offered.

### DATA MANAGEMENT

From entry to archiving, data management is a breeze for the SevenCompact meters. You can enter your sample, user IDs or sensor IDs through three points of entry; an integrated keyboard, a barcode reader, and a USB keyboard. The SevenCompact™ can manage up to 1,000 sets of data. The data can then be filtered by memory number, measurement type and sample ID. Once the data is filtered, you have the option to review, print or export by USB.

### PROTECTION

The meters have been designed to withstand dust and spills of aqueous solutions. Both meters are equipped with an IP54 rating for resistance to dust and water. There are extra protectors for the connections specifically, as well as a transparent exterior cover.

### SERVICE SUPPORT

The meters come with a wide range of services to find a solution for every need. Compliance is made easy with the calibration certificate, ensuring your next audit produces satisfying results. Another option is the effortless Instrument Qualification and Operational Qualification (IQ/OQ) package. There is proof of professional installation and commissioning meeting regulation and quality standards.

### PERIPHERALS

There are various options to connect peripherals simultaneously to meet your needs! The plug and play USB interfaces are recognized immediately by the meter and visually indicated with an icon on the display. Printers with RS232 interfaces are fully supported and automatically detected, and the settings immediately adjust accordingly. Another option is LabX direct pH software which archives your results quickly and reliably by transferring data to an application such as MS Excel.

# MAKING THE MOST OF MAINTENANCE OPTIONS

Best practices dictate that pipettes undergo preventive maintenance and calibration at least once per year. Calibration involves dispensing set volumes of a liquid, usually water, into the weighing pan of a calibrated balance. Service personnel correct for temperature, humidity, and atmospheric pressure, and then compare the expected weight to the actual weight. Among the numerous service options are end-user, in-house instrument service groups, third-party maintenance organizations, and the original manufacturer. All have their benefits and drawbacks.

Small, independent service providers are numerous and focus on academic customers within a relatively small geographic area. Regardless of their size, service organizations work either through “depot” arrangements (pipettes are boxed and shipped to the servicer) or on-site. Servicers generally do not require a minimum number of devices for depot service, but all have requirements for on-site service.

The fly in the ointment for third-party servicing in general is the electronic pipette. Although electronic pipettes comprise just 7–8 percent of all pipettes in use today, electronic models are the fastest-growing segment of pipette products. Multichannel pipettes make up approximately 20 percent of sales,

while standard, single-channel piston and o-ring devices comprise about 70 percent of the market.

“Most service providers can easily service standard pipettes,” says Joe Fredette, product director for liquid handling and consumables at Thermo Fisher Scientific (Hudson, NH). Thermo Fisher and other manufacturers provide calibration and service instructions freely to users who choose to service their own pipettes. But electronic pipettes, which contain printed circuit boards and onboard logic for storing methods, can be challenging. “They require a professional service provider,” Mr. Fredette adds.

Users who service their own pipettes have several options. A&D Weighing (San Jose, CA) sells a dedicated balance for pipette test-

“Any organization can perform its own calibration and routine service. Whether they are actually interested [in doing so] is another matter,” observes Markus Jansons, weighing products manager at A&D. “You need to have a relatively large number of pipettes to justify dedicating equipment and personnel to pipette calibration.”

Remember, though, that pipetting is susceptible to end-user technique, and what holds for pipetting in general is doubly true for pipette calibration.

Due to issues of time and convenience, demand is rising for servicing pipettes on the customers’ premises, but hard-core metrologists protest that control over environmental conditions is impossible. Rigorous depot calibrations take place in

**“Pipetting is susceptible to end-user technique, and what holds for pipetting in general is doubly true for pipette calibration.”**

ing, as well as accessories for servicing pipettes that work with their standard scales. The main components are software and an evaporation trap to ensure that very low liquid volumes do not evaporate or pick up moisture from the air. A&D also sells a leak tester that induces a vacuum to detect leaks in pipette seals, pistons, or o-rings.

environmentally controlled rooms. “Saying that you’re not getting a true calibration is a bit hard-line,” says Mr. Fredette. “But in fact, what many users receive on-site is not a calibration, but a service check.”

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Oxford Instruments	www.oxford-instruments.com
Rainin Instrument Company	www.rainin.com
Thermo Fisher Scientific	www.thermofisher.com
USA Scientific	www.usascientific.com
VistaLab Technologies	www.vistalab.com
Wheaton Science Products	www.wheatonsci.com

VistaLab Technologies, Inc.

Ovation pipettes take stress and fatigue out of complex liquid handling tasks and plate preparations

Ovation® BioNatural pipettes are the ideal ergonomic solution for handling repetitive and complex liquid handling tasks that contribute to stress injuries in today's laboratory. Ovation pipettes increase laboratory efficiency through automated liquid handling routines, while reducing fatigue and the effect of poor postures.

The Ovation BioNatural Pipette is the only pipette designed to keep your hand in the neutral position recommended by ergonomics experts. It allows a lower hand location to ease stress in the shoulder, and a relaxed wrist angle eliminates uncomfortable extension and twist

movements in the arm. Force, velocity and exertion from repetition or duration have also been neutralized because of the Ovation pipette's unique working position and reduced forces required during operation.

Applications and techniques in areas such as molecular biology, drug discovery, microbiology, immunology and other research disciplines utilizing high throughput screening procedures have heightened the demand for highly accurate and precise multichannel pipettes. While multichannel pipettes have been available for years, their use has been notably problematic in a number of areas such as tip loading and retention, inconsistent performance across all channels, time consuming programming steps and excessive operational forces, especially for tip ejection. Additionally, the sheer amount of pipetting required for many procedures can easily cause hand fatigue and increased risk of repetitive stress injuries, even with correct pipetting techniques.

Ovation Multichannel pipettes incorporate numerous features not found in other multichannel pipettes that complement its ergonomically-correct, comfort-driven design. Physical efforts and time required for tip handling have been minimized with a unique tip acquisition system which provides the user with a visual indicator and audible "click" to indicate all tips have been securely fitted. Tip ejection is accomplished just as quickly and with minimal effort at the gentle push of a button.

The Ovation Multichannel's intuitive user interface allows easy set-up and use of a number of liquid handling functions designed to simplify the complex demands of multiple-step microplate procedures.

A *Multiple Dispense* function allows the user to establish a dispense volume, number of dispenses desired and speed of the dispense, then automatically calculates and aspirates the total volume required. Individual aliquots are performed on demand by pressing the pipetting trigger. Pace, a timed-interval dispensing utility, can also be activated to automate and speed through the dispensing process.

A *Serial Dilute* function performs sequential dilutions, where an initial sample volume is aspirated, dispensed into diluent, mixed, and then a desired amount of diluted sample is then aspirated for addition to the next diluent. The pipette's *Mix* function can also be used independently in other procedures where repetitive cycles of aspirating and dispensing of the same sample is desired.

For applications requiring highly volatile or viscous samples, or small microvolumes, a *Reverse Pipette* function is available, where a slight overage of sample volume is aspirated, and after the exact aliquot volume is dispensed, liquid remaining in the tip is purged independently.

Three user-defined *pre-set volume* settings can also be programmed and recalled at any time for routine aspiration and dispensing on the fly.

With the use of microplates increasing to keep up with research and productivity demands, the need for innovative laboratory equipment that can improve efficiency has never been greater. The Ovation multichannel makes it possible for scientists to maximize their productivity, and improve performance with uncompromised confidence. Color-coded 8 and 12 channel models are available in right and left handed models for liquid handling from 0.5µL to 1250µL.

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## Gilson PIPETMAN® L Pipette

Gilson is proud to announce the release of PIPETMAN® L, the latest innovation from Gilson PIPETMAN®, the pipetting standard for nearly 40 years. PIPETMAN L is an adjustable volume pipette that features a Gilson patented volume locking system. Once you lock the thumbwheel, the operating rod is no longer in contact with

pipetman® L

1-800-445-7661 | [www.pipetman.com](http://www.pipetman.com)

the counter assembly which is responsible for changing the volume; as you pipette, the volume cannot be accidentally changed — a concern in some manual pipettes. This GLP feature, among other features, meets the current needs of intensive pipette users who desire accuracy and precision without sacrificing comfort.

### LOW FORCES, LIGHTWEIGHT, LOCKABLE VOLUME

PIPETMAN® L is the latest innovation of Gilson based on ergonomics, comfort and traceability research. This new mechanical pipette combines the PIPETMAN Classic™ legendary robustness, a newly designed body, and state-of-the-art internal mechanism.

With the PIPETMAN L you can now enjoy an extremely lightweight pipette, which has been designed to fit naturally in your hand. Its new shape ensures a perfect fit in any hand and the new hook reduces tensions while holding it. An adjustable tip ejector button has also been implemented to adapt to both right- and left-handed users. Its shape provides intuitive and comfortable handling of the pipette whatever the size of your hand and allows for a reduction in tip ejection forces by up to 50% over the PIPETMAN Neo.

This new pipette has no shortage of GLP features to give you peace-of-mind while pipetting. In addition to the patented-lockable volume mechanism, Gilson has added a unique 2D identification bar code to each pipette which, when scanned with a universal scanner, you can download the product reference, date of manufacture, serial number and nominal volume information.

PIPETMAN L offers the superior comfort you require for your applications. PIPETMAN L is available in 8 single channel models from 2 µL to 10 mL, covering the volume range of 0.2 µL to 10 mL. Offering two tip ejector styles, plastic and stainless steel, PIPETMAN L is perfect for both corrosive and non-corrosive samples. Both tip ejector styles are equipped with a clip ejector for convenient access to serviceable parts. Like other PIPETMAN families, PIPETMAN L is fitted with a universal tip holder that allows for a secure fit of most leading brands of tips, so there is no need for a dedicated tip brand. You asked, we delivered; comfortable pipette to help you increase your daily throughput without forfeiting accuracy and precision.



## ErgoOne® Adjustable Volume Pipettes

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### REPRODUCIBLE RESULTS

ErgoOne® pipettes are engineered and manufactured to meet strict accuracy and precision specifications. High quality materials provide reproducible results day after day. Each pipette carries an individual serial number and is supplied with a certificate of EN ISO 8655 quality test results. The four-digit display helps you specify a more accurate and reproducible volume, while the volume control locks into place to eliminate drifting or changing during use.

### STRESS-RELIEVING ERGONOMIC DESIGN

Smooth, even plunger forces give you maximum control over sample delivery while minimizing repetitive strain. Tip application requires minimal pressure for complete sealing, and the light, balanced weight reduces fatigue. The handle and curved support hook promote a natural, relaxed grip, and the body length has been optimized for reduced arm stress.

The four-digit volume display is positioned for easy viewing by both left and right-handed users. Volume changes can be made quickly with minimal effort, and our popular No-Drift™ volume lock can be set and released with just one hand.

ErgoOne® multichannel tip cone o-rings reduce the tip attachment and ejection forces required for 100 µL and 300 µL pipettes. O-rings also reduce wear on the tip cones and provide better sealing and compatibility with various tips.

### DESIGNED BY RESEARCHERS

We put our years of liquid handling experience to work to create a pipette that reflects your needs. Consulting with laboratory researchers throughout the process, our design team combined the most requested features with the latest ergonomic findings to create an optimized pipette that will become your new favorite.

We also respect your desire to use your choice of pipette tips. ErgoOne® works with TipOne® and other universal tips. We won't lock you in with a proprietary tip, but we do recommend TipOne® for exceptional fit and performance.

### DURABLE CONSTRUCTION

ErgoOne® pipettes will withstand the rigors of daily laboratory use and are fully autoclavable. The exterior is made with durable UV- and chemical-resistant polypropylene. Single channel 2.5 µL, 10 µL, and 20 µL ultra micro pipettes have stainless steel tip cones for longer life. All ErgoOne® pipettes have a three-year warranty.

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# CHARGING UP THE LAB

Power supplies provide steady, precisely controlled electrical energy to electronic equipment.

One type of supply, the uninterruptible power supply, powers electronics in the event of an emergency by keeping a battery constantly charged. When the main power goes out, the battery takes over before the equipment can power down.

Uninterruptible power supplies are rather uncommon in most labs, except for stand-alone computer equipment that might suffer from data loss.

Academic and industrial research organizations usually have house backup generators for heavy equipment and instrumentation, and backups for both computer power and data.

Most common lab instruments have their own integrated power supplies, which enable users to plug them into a common electrical wall outlet. The power supply first uses a rectifier to convert house alternating current (AC) into direct current (DC), the only type that common instruments and devices use. It then adjusts the current and/or voltage upward or downward to meet the needs of the instrument. Throughout the device's circuitry, additional power circuits step up or step down the current according to the various subcircuits' needs.

One way to differentiate power supplies is to look at how they operate. Switching power supplies use a switching generator to harness efficiencies when converting electrical energy from the grid's AC to specific DC current and voltage requirements. Switching supplies work by rapidly turning on and off. Linear power supplies operate at constant, precisely controlled voltages.

**“One way to differentiate power supplies is to look at how they operate.”**

Switching power supplies are common as embedded supplies for personal computers because of their high efficiency and small footprint, but they tend to be electrically noisy and don't regulate as well as linear power supplies, says David Pereles, marketing segment manager at Tektronix (Beaverton, OR).

Stand-alone power supplies, including uninterruptible supplies, do make sense in non-electronics labs when a lot of equipment runs on the same voltage, says Mark Swift, business development manager at Universal Electric (Canonsburg, PA). “It's easier to provide the right electrical energy from a single piece of gear.” Other benefits are ease of connectivity and protection against heat or loss of power.

Physics and chemistry labs, particularly R&D and academic labs,

use power supplies to drive basic equipment or to supply direct current in much the same way as a battery.

Electrical/electronics lab power supplies come in three major types, depending on the work being done. Constant voltage supplies provide configurable DC voltage that is adjustable over a specific range that includes zero voltage. Constant current supplies

output-regulated current independent of the voltage. Constant voltage/constant current devices provide either voltage or current.

Varying voltage or current is common when prototyping an electrical circuit to do a particular task, such as timing, counting, or signal processing. “Certain circuits rely on variable voltage thresholds,” Mr. Pereles says. “Changing the voltage is useful when performing a comparison of how the circuit operates at different voltages, or in supplying accurate reference voltages or currents.”

Mr. Pereles says that when choosing the right power supply, the first consideration is what voltage and current are needed followed by how many outputs are required.

## RECENTLY RELEASED POWER SUPPLIES

### Model 1693, 1694, 1900, 1901, and 1902 DC Power Supplies

- Switch mode power supplies provide current up to 60 amps and power up to 960 watts
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EMCO High Voltage  
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### Starline Plug-in Raceway

- Available in 20, 40 or 60 amps bussing; 120V or 240V; 5 wire
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Universal Electric

[Uecorp.com](http://Uecorp.com)

## POWER SUPPLY MANUFACTURERS

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B&K Precision [www.bkprecision.com](http://www.bkprecision.com)

EMCO High Voltage [www.emcohighvoltage.com](http://www.emcohighvoltage.com)

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Universal Electric [www.uecorp.com](http://www.uecorp.com)

# UNIVERSAL CONCENTRATION METERS

Refractometers are instruments that quantify and identify chemicals and materials based on their refractive index (RI). A unique property related to the speed of light as it passes through a substance, RI is defined as the ratio of the speed of light in a vacuum relative to its speed in the test material.

Since light also changes direction as it passes from one medium to another, RI is conveniently measured as a function of this unique “angle of refraction.” Everyone is familiar with how a partially submerged stick seems to “bend” as it enters water. Refractometers quantify RI by measuring the angle formed by light as it leaves air and enters the test object.

Refractometry is one of the most versatile analytical techniques. Pure substances that transmit light have unique RIs that change as the concentration of additives changes. For example, the RI rises with increasing sugar concentration since sugar molecules dissolving in water slow light down as it passes through.

As a “universal concentration meter,” refractometry serves a range of industries: water treatment, chemistry, biology, foods, beverages, brewing and viticulture, paints, lubricants, personal care products, pharmaceuticals, and many others. Manufacturers routinely use RI to check incoming raw materials as well as complex

ing director at Rudolph Research Analytical (Hackettstown, NJ).

Protecting the sample during measurement is another precaution. Volatile liquids like alcohol evaporate, which distorts the concentration, while hygroscopic liquids like glycerol can dilute if they pick up water. “You also want to make sure there is no temperature gradient across the sample,” Mr. Spanier warns, since RI is a function of temperature.

Unlike spectroscopy, RI is not diagnostic or conclusive for a particular ingredient—a sugar-water solution may have the same RI as a saltwater solution (albeit at different concentrations). RI is most appropriately applied when analytes are known,

or when the RI of a finished product has been previously established.

Noah Radford, a technical specialist at Atago U.S.A. (Bellevue, WA),

says users should carefully consider the composition and value of what they seek to measure, the measurement accuracy required, and the cost of an incorrect analysis. “Also consider the testing environment, temperature and humidity conditions, and whether you’re measuring in a controlled laboratory setting or on a manufacturing floor.”

**“Refractometers range in size and capability, from handheld units costing a few hundred dollars to full-featured instruments in the \$10,000 to \$15,000 range.”**

Refractometers range in size and capability, from handheld units costing a few hundred dollars to full-featured instruments in the \$10,000 to \$15,000 range. Handheld models may be of “traditional” or digital design; higher-end instruments operate on a benchtop or, in some industries, in-line to monitor manufacturing processes. Refractometers are priced to fit the job and the value of what is being analyzed.

products used in manufacturing, research, and development.

Refractometers in constant use must be maintained, primarily by cleaning the prism. If this is not done after every test, fluid from the previous run will evaporate, leaving the solute on the prism and distorting the next measurement. “Cross-contamination between samples is another source of error,” observes Richard Spanier, sales and market-

## RECENTLY RELEASED REFRACTOMETERS

### Abbemat Series

- Sophisticated measuring principle guarantees maximum accuracy
- Low sample volume, highest efficiency
- Simple to adjust
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### HI 96811 Digital Wine Refractometer

- Rugged portable, water resistant device that is easy to use and calibrate
- Employs the measurement of refractive index to display the sugar content in grape samples
- Within 1.5 seconds, the instrument measures the refractive index of the grape sample and converts it to % Brix concentration units



Hanna Instruments

[www.hannainst.com/usa](http://www.hannainst.com/usa)

### PRM-100a

- Easily incorporated in piping of manufacturing plants, liquid mixing devices, and washing apparatuses to measure the concentration of various liquids
- Measurement accuracy: Brix  $\pm 0.05\%$ , nD  $\pm 0.00010$
- Prism is specially designed to prevent solid materials from collecting on the surface, even after extended periods of use



ATAGO U.S.A.

[www.atago.net](http://www.atago.net)

### Brix/RI-Chek Digital Pocket-Sized

- Multi-scale unit measures % Brix Temperature Compensated, Refractive Index Temperature Compensated, and Refractive Index at actual temperature
- Weighs 100 grams and can fit into a shirt pocket
- Includes a detachable neck lanyard, non-slip side grips for ease of handling, and a durable storage case



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## REFRACTOMETER MANUFACTURERS

Anton Paar

[www.anton-paar.com](http://www.anton-paar.com)

ATAGO U.S.A., Inc.

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[www.hannainst.com/usa](http://www.hannainst.com/usa)

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# ENERGY EFFICIENCY A BIG FACTOR

Lab refrigerators and freezers are similar in construction to household units, and come in a variety of temperature ranges, shapes and sizes.

Freezer and refrigeration options fall into four general temperature categories: +4°C refrigerators for chromatography supplies, blood storage, and pharmaceuticals; -20°C (and below) freezers for enzymes and biochemicals; -30°C to -40°C for biological samples, and -80°C freezers for long-term storage and stability. Units range in size from under-counter systems as small as 3.6 cu. ft., to standalone chests as large as 70 cu. ft.

After considering temperature capabilities, capacity and footprint, choosing among lab refrigerators and freezers often reduces to secondary or subjective criteria. Eye-level controls, mechanisms to prevent door freezing and/or vacuum pressure build-up, space-saving insulation, automated data recording, alarms, digital temperature control, rapid temperature recovery after door openings, temperature uniformity throughout the box, and condition monitoring are differentiators. However, purchase decisions often come down to brand name recognition, perceived reliability, price and availability.

Tamper-proof temperature logging and recording are desirable features for regulated industries and those called on to testify in court. Thermo Fisher Scientific (Marietta, OH) plans to offer a wireless record-

ing/logging option in 2010, but companies have been slow to adopt such equipment due to difficulties in changing established SOPs. The traditional chart recorder is still the industry standard for temperature monitoring. However, most industries are moving toward electronic temperature monitoring.

One notable development in refrigeration has been the emergence of cold storage to support vaccine work, particularly for H1N1 influenza vaccine storage. H1N1 vaccine is stored within a narrow temperature range (35°F to 46°F), and health agencies mandate twice-daily temperature measurements.

Many labs use household kitchen refrigerators to store very low-risk laboratory materials, but these units

Energy efficiency has become a key driver in refrigerator/freezer purchase decisions. Many vendors have been working with the U.S. Environmental Protection Agency to establish industry-wide Energy Star standards for lab refrigerators and freezers, which surprisingly do not yet exist. Beginning in late 2008, vendors began submitting energy efficiency and performance data to EPA, from which the agency will eventually issue guidelines for the coveted Energy Star designation. Energy consumption for “always-on” appliances is a serious concern for large organizations like pharmaceutical companies and universities.

“Due to their heavy usage, lab refrigerators and freezers will never be as energy efficient as units purchased

**“Due to their heavy usage, lab refrigerators and freezers will never be as energy efficient as units purchased for the home,” said Gordon Shields of Thermo Fisher Scientific.’**

are designed for low-traffic use and lack the precise temperature control and refrigeration capabilities of lab-designed units. Several vendors have nevertheless made a business of refurbishing and retrofitting home-appliance cooling chests for labs. Common upgrades include alarms, controllers, door locks and special shelving.

for the home,” said Gordon Shields, director for cold storage at Thermo Fisher Scientific. “The key is to reduce overall energy usage while maintaining performance.”

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SHEL LAB	<a href="http://www.shellab.com">www.shellab.com</a>
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Nor-Lake® Scientific Select™ laboratory Refrigerators and Freezers are designed for heavy-duty long term cold storage for a wide range of demanding laboratory, scientific, pharmacy and life science applications. Product selection includes full-size reach-in +4C Solid and Glass Door Refrigerators, Sliding Glass Door Refrigerators, Pass-thru Refrigerators and -25C Freezers. Select™ Refrigerator and Freezer models are available with one, two or three doors. Pass-thru models are available in two, four and six door configurations with solid or glass door combinations. Chamber capacities include internal volumes of 24ft3, 33ft3, 53ft2 and 80ft3.

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Select™ models feature advanced digital LCD 4x20 character display, microprocessor control system with key pad. Includes audible and visual high/low alarms, 2 product sensors with glycerin bottles, 2 to 10 volt DC output, remote alarm contacts, door ajar alarm, password protection of set points and factory settings, real time clock, operation diagnostic monitoring of defrost, compressor and fan, low and high alarm test, event logging and sensor failure alarm.

Cabinet construction features include white painted exterior front, sides and back, with galvanized steel on the top and bottom. The interior is white and there are three epoxy-coated shelves per door, which can be adjusted in 1" increments. Standard features include interior lights (switch activated), easy roll low profile casters, magnetic door gaskets, key door locks, and 1" diameter lead sensor port.

Cabinets are formed-in-place with high-density CFC-free polyurethane foam insulation. Doors have heavy-duty pivot hinges and pull handles. Select™ Refrigerators and Freezers feature top-mounted refrigeration, air-cooled condensing unit and automatic condensate evaporation. The combined features of the Select™ control refrigeration system and cabinet construction produce a precise, uniform controlled temperature environment and energy efficient operation for long lasting reliable and durable performance.

Available options (depending on model) include: extra shelves, stainless steel drawers, sliding basket drawers, temperature chart recorder and chart paper, stainless steel interior and/or exterior, reverse hinge doors, 4-20ma output, RS485, seismic mounting, Secure Guard lock system, internal electrical outlet, access port 2" sleeve with cover and export crating.



▲ Nor-Lake® Scientific pass-thru refrigerators have a front door and a rear door, so they can be accessed from two sides. They are available with one pair, two pairs or three pairs of doors in a variety of materials: with glass front door and solid back door, with all glass doors or with all solid doors. Available with sliding baskets as shown.



# Marvel Scientific: Refrigeration for Health, Science and Industry

## Serious about Standards

In laboratories worldwide, household refrigerators are pressed into duties they were not designed to fulfill. When these units operate inconsistently or fail, consequences can range from inconvenient to costly to dangerous. At Marvel Scientific, we believe it's time to get serious about standards. Marvel Scientific refrigeration products are engineered and constructed to meet or exceed the stringent standards required by health, science and industry. Each general purpose, flammable material storage and explosion proof product has been designed specifically for the lab with a Commercial UL Listing for your peace of mind. Let Marvel Scientific help you professionally protect your research, your specimens and your lab.



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New general purpose lab refrigerators feature the exclusive MicroSentry™ Scientific refrigeration control, with the ability to control, confirm and capture temperature performance, giving you the ultimate confidence in your refrigeration.

The MicroSentry™ Scientific control is an interior-mounted digital electronic control that allows you to set temperature, high/low alarm values and alarm delay period. Temperature is confirmed via the large LED display and audible/visual alarms notify if there is a high/low temperature event or if the door is left open. A remote alarm interface allows communication of any alarm event, including power failure, to a remote or central monitoring system.

There is a history record of high/low temperatures for monitoring programs, and notification of periodic maintenance and diagnostic codes.

Lab refrigerators with the MicroSentry™ Scientific control are available in 15" and 24" undercounter models, with either a solid or glass door. All models are front vented so they can be built into casework with zero clearance.

## Innovative Two-Drawer Lab Refrigerator

Marvel Scientific's 6CRDE is the first Two-Drawer Undercounter Lab Refrigerator with a Commercial UL Listing. The unique configuration

allows full access even from a seated position. Two super glide, full-extension drawers store all types of containers and provide superior visibility and access—no more reaching to the back of a crowded refrigerator shelf.

The two-drawer lab refrigerator features interior lighting, automatic defrost, hidden touchpad controls with LED digital display, extra deep drawers and heavy duty drawer slides for full loads. Full-wrap drawer fronts come in white or stainless steel with matching handles.

## ADA Height Lab Refrigerator

Designed to comply with the height standards set by the Americans with Disabilities Act (ADA), Marvel Scientific's 6CADM general purpose laboratory refrigerator addresses the differing physical needs of individuals.

Title III of the ADA requires that all new construction of, or modification to, public and commercial facilities be accessible to individuals with disabilities. Because the 5.4 cu. ft. laboratory refrigerator is built for lower countertops and users of all abilities, its design includes numerous unique features. Two slide-out shelves feature safety stops to prevent shelves from being disengaged from the refrigerator. The top half-shelf provides space along its right side to vertically store tall items on the shelf below.

The model 6CADM now features the MicroSentry™ Scientific controller, ultra efficient compressor, lifetime fan motor, and Commercial UL and C-UL listing to ensure optimum performance and unwavering reliability. An optional door lock and access port are available when product security or alarm probes installation require them.



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Easy-to-use touch navigation guides the user through the i.C3. Audible and visual indicators and alarms alert users to out-of-range conditions so that prompt action can be taken. Settings parameters are password protected providing further security.

The interactive temperature graph provides access to temperature data over the previous 42 days and can be viewed in daily or weekly increments. Alarm conditions, alarm tests, and defrost events are all recorded on the graph. Temperature data, including alarms and tests, can be downloaded and saved.

i.Act™ on-screen event acknowledgement allows users to immediately record corrective action at the time of the event. Information is date stamped to validate each entry and can not be changed providing a secure record of every corrective action. Data records can also be downloaded.

Optional i.D™ Integrated Electronic Access Control offers secure access to the unit via on-screen PIN entry. It provides data capture of who accessed the unit and documents how and when this occurred. The Access Control display can be used as an alternative Home screen allowing users to customize each unit.

In addition to the i.C3, i.Series models will now feature more capacity, energy saving LED spot lighting, rechargeable battery backup, and optional leveling feet.



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# ROLLING YOUR OWN PROVIDES SAFETY, ECONOMY

The prospect of gas cylinder accidents inspires awe and fear in lab workers. However, a safer alternative exists for some of the more common specialty gases: on-site or point-of-use generation that uses membranes, catalysts, or pressure swing absorption to generate pure gases from air or water.

The point of on-site generation is to avoid storage by generating gas as it is needed. Gone are tanks and everything associated with them: rental, delivery, supply, and accidents.

In situ nitrogen generation is a membrane process; hydrogen is generated through electrolysis of deionized water using a palladium membrane catalyst.

"We've been in this market since 1989," notes Phil Allison, global business leader for gas-generation products at Parker Hannifin (Haverhill, MA). "Most of the on-site gas-generating technologies are the same as those available at industrial scale, but in miniaturized form."

One exception is zero-grade (hydrocarbon-depleted) air, which is produced at the plant by blending very pure oxygen and nitrogen. At the benchtop, the gas generator uses

a compressed air feedstock, purifies it, then uses a catalyst to oxidize out the hydrocarbons.

Point-of-use production varies significantly among gases. Because nitrogen is the principal component of air (78% by volume, 75% by weight), on-site generation systems produce the equivalent of about seven cylinders per day. Zero-grade air generation has a capacity of about 140 liters per minute.

**"A typical analytical laboratory using two gas chromatographs could save \$20,000 per year by generating its hydrogen gas at the point of use."**

For hydrogen, generators produce anywhere from 100 milliliters to 20 liters per minute.

A recent study by Loctite, a subsidiary of chemical giant Henkel, found that a typical analytical laboratory using two gas chromatographs could save \$20,000 per year by generating its hydrogen gas at the point of use. Hydrogen cylinders are normally trucked in and stored in a utility area or directly behind the GC. When the main tank empties, the analytical operation shuts down unless a backup tank is on-site. The purity of point-of-use hydrogen is 99.99999 percent.

On-site hydrogen generation makes sense even for labs that only occasionally use hydrogen. "Why would you want to spend \$5,000 per year on cylinder gas when you can buy a generator for \$8K which pays for itself in less than two years?" Mr. Allison asks.

Hydrogen is normally associated with GCs as the gas that fuels the instrument's flame ionization detector (FID). Increasingly, labs are using hydrogen as the carrier gas.

According to John Speranza, VP of sales at Proton Onsite (Wallingford, CT) the cost of

helium has reached \$200 per tank—twice that of hydrogen. Labs that are able to, are switching in droves from helium to hydrogen, he says. Stagnant capacity and increased demand are behind the rise in helium prices.

"Not only is hydrogen half the price of helium, but that gas's lower viscosity makes gas chromatography more efficient," Mr. Speranza says. "And this is not a temporary situation."

Chromatographers considering the switch may need to re-validate their methods, but otherwise the switch is seamless.



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Gasco	www.gascogas.com
Linde	www.linde-gas.com
Matheson Tri-Gas	www.matheson-trigas.com
Norlab	www.norlab-gas.com
Parker Balston	www.labgasgenerators.com
Praxair	www.praxair.com
Proton Onsite	www.protononsite.com
VICI Metronics	www.vici.com

DETECTING AND QUANTIFYING CARBON CONTENT

Total organic carbon (TOC) analyzers are a mainstay in industries that must detect and quantify carbon content from many samples and sources. Unlike spectroscopy, which measures specific carbon species from their unique interactions with light, TOC analysis doesn't tell which specific carbon-containing species are present. Nevertheless, it does provide information on impurities, which is invaluable in evaluating environmental samples. TOC analysis is mandatory for many labs, particularly in semiconductors for process water; or in regulated industries that work with ultrapure water for processing, instrumentation, cleaning/cleaning validation, or human drugs. Other industries that regularly employ TOC analysis include pharmaceuticals, foods, forensics, oil and gas, and the life sciences.

TOC analysis involves sample acidification and oxidation down to CO<sub>2</sub>, followed by detection and quantification. Acidification is used to remove inorganic carbon; oxidation occurs either through direct, high-temperature (1300°C) or catalytic (680°C) combustion, or through a technique involving either ultraviolet radiation or thermal oxidation in the presence of persulfate.

The detector is the heart of TOC analyzers. Two main techniques are used to quantify carbon dioxide: conductivity and non-dispersive infrared (NDIR). Conductivity is a straightforward measurement involving either

direct measurement or membrane-based analysis. Direct conductivity has a limited analysis range but is inexpensive, doesn't require carrier gas, and is sensitive to parts-per-billion (ppb) levels. Membrane-based conductivity is somewhat more complicated and takes longer, but is more robust and provides a greater analysis dynamic range.

NDIR should be considered the detection method of choice because

**“As it catches on, TOC analysis on solids could replace approved, legacy test methods that were developed years ago.”**

it is interference-free and directly measures TOC generated during the oxidation step. Static pressurized concentration (SPC) provides improved sensitivity and precision by concentrating the oxidized sample and measuring it all at once instead of through a flow cell.

One emerging trend in TOC is the analysis of solids. Jeff Lane, a TOC specialist at OI Analytical (College State, TX), says his company is working on a new solids module that captures CO<sub>2</sub> in a sampling bag that collects oxidized material from rep-

licate samples. “Solids work because samples are not always as homogeneous as liquids or suspensions,” says Mr. Lane. “A collector bag helps overcome heterogeneity.”

Once the gas is collected, it can feed into a cavity ring spectrometer or even a mass spectrometer, which provides both TOC values and 12C13C isotope ratios, which are useful in determining the geographic origins of carbon-containing materials. Environmentalists have considered using isotope ratios from feathers or droppings to map bird migration, forensic food scientists use it to pinpoint the origins of high-value products such as olive oil, and pharmaceutical companies employ isotopes to detect counterfeits.

As it catches on, TOC analysis on solids could replace approved, legacy test methods that were developed years ago for materials not normally thought of as carbon-bearing, such as concrete. This will take time, Mr. Lane says, because “only a certain number of people are willing to overcome inertia.”

Customers considering the purchase of a TOC analyzer, and particularly wondering whether to acquire a combustion or persulfate oxidation model, should consider potential down time and ongoing direct costs together.

RECENTLY RELEASED TOC ANALYZERS

**Multi N/C 3100**

- Suitable for all samples
- Includes Focus Radiation NDIR-Detector and VITA® Flow Management System
- Catalytic high-temperature oxidation up to 950°C
- High sensitivity down to the lowest ppb range

Analytik Jena [www.analytik-jena.com](http://www.analytik-jena.com)



**Model 9210p and Model 9210e On-Line**

- Provide analysts with a reliable tool for Online TOC monitoring
- Includes analyzers built around wet chemical (Model 9210p), electrochemical (Model 9210e), and UV oxidation
- Configured for ease of use and to reduce utility requirements

OI Analytical [www.oico.com](http://www.oico.com)



**Sievers 5310 C**

- Designed specifically for municipal drinking water applications
- Offers 12-month calibration stability and complies with USEPA-approved methodology
- Features automated protocols such as TOC percent removal calculation
- Suitable for raw and finished drinking water monitoring for DBP compliance

GE Analytical Instruments [www.geinstruments.com](http://www.geinstruments.com)



**TOC-L Series**

- Features a wide sample range from 4 µg/L to 30,000 mg/L
- Uses a proprietary 680°C combustion catalytic oxidation method to analyze all organic compounds
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- High-precision mass flow controllers ensure uninterrupted carrier gas

Shimadzu [www.ssi.shimadzu.com](http://www.ssi.shimadzu.com)



TOC ANALYZER MANUFACTURERS

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EST Analytical	<a href="http://www.estanalytical.com">www.estanalytical.com</a>
GE Analytical Instruments	<a href="http://www.geinstruments.com">www.geinstruments.com</a>
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Mettler Toledo	<a href="http://www.mt.com">www.mt.com</a>
OI Analytical	<a href="http://www.oico.com">www.oico.com</a>
Parker Balston	<a href="http://www.balstonfilters.com">www.balstonfilters.com</a>
Shimadzu	<a href="http://www.ssi.shimadzu.com">www.ssi.shimadzu.com</a>
Skalar Analytical	<a href="http://www.skalar.com">www.skalar.com</a>
Teledyne	<a href="http://www.teledyne.com">www.teledyne.com</a>
Thermo Fisher Scientific	<a href="http://www.thermofisher.com">www.thermofisher.com</a>
TOC Systems	<a href="http://www.tocsystemsinc.com">www.tocsystemsinc.com</a>
UIC	<a href="http://www.uicinc.co">www.uicinc.co</a>

MORE OPTIONS FOR GREEN, REMOTE OPERATION

Oil-free diaphragm pumps have earned a reputation for environmental-friendliness for low- to medium-pressure applications. At the low-pressure end, pumps do not continuously send water down the drain as do aspirators and there is no contaminated oil to deal with. The pumps have a long operational life with minimal maintenance and DC voltage models are said to be more energy efficient.

High foreline pressure tolerance permits the use of a smaller, low-cost backing pump. “Turbomolecular pumps cannot discharge directly to the atmospheric pressure, only up to 10 mbar absolute pressure at its outlet, hence the need for a backing pump,” explains Mauro

genico pumps. “The latter are far less flexible, however, due to the required regeneration cycles,” Mr. Nebiolo says.

Ultra-high vacuums may otherwise be reached using sputter ion pumps, titanium sublimation pumps, and getter pumps. The latter rely on a “non-evaporable getter,” an aluminum-zirconium alloy that soaks up gases by forming non-evaporable or non-sublimable compounds with them.

Vacuum pumps are commonly specified both by ultimate vacuum and by flow rate. The flow rate is also known as pumping speed (the “volume flow rate” at the inlet, measured in volume per unit time) or free air displacement (the volume

of air that flows into the pump, per unit time, when inlet and outlet are at atmospheric pressure).

these conditions,” says Peter Coffey, vice president of sales and marketing at Vacuubrand (Essex, CT). Pumps with identical specifications for flow rate and ultimate vacuum can perform very differently between these two end points. “So if you only use these terms to select a pump, you don’t know what performance you will get out of the pump under actual lab conditions,” he says.

In other words, users need to know how the pump behaves between these two end points—when the pump is both creating the vacuum and moving vapor.

There are two ways to determine pump performance at the vacuum pressure you need. One is to ask your vacuum pump vendor while the other is to rely on vacuum pump performance curves that all reputable vendors will provide on request.

Depending on pump engineering, the actual pumping speed falls off at a greater or lesser rate as the pressure approaches the ultimate vacuum. The better the pump, the more the specified pumping speed is preserved closer to the ultimate vacuum.

“Pumps with identical specifications for flow rate and ultimate vacuum can perform very differently.”

Nebiolo, director of global marketing for vacuum products at Agilent.

The turbomolecular pumps are suitable for achieving high vacuum and ultra-high vacuum, with operating pressure ranging from 10<sup>-1</sup> to 10<sup>-11</sup> mbar inlet pressure.

High vacuum may also be achieved through a diffusion pump, which is not as clean as the turbomolecular design, or cryo-

outlet are at atmospheric pressure). Ultimate vacuum is the deepest vacuum the pump can reach, the point at which the effective pumping speed is zero.

“The problem is that the pump can’t move any vapor at ultimate vacuum, and at a specified pumping speed, the pump is working as a fan, not a vacuum pump. No one uses a vacuum pump to work at either of



## RECENTLY RELEASED VACUUM PUMP PRODUCTS

### 4UHV Ion Pump Controller

- Able to power, control and monitor independently up to four ion pumps, with capacities ranging from 20 to 500 liters per second each
- Eliminates or shrinks electrical noise filters in critical applications
- Shares its communication protocol with Agilent's other controllers for turbomolecular and pre-vacuum pumps, so less engineering work is required



Agilent

[www.agilent.com](http://www.agilent.com)

### Dolphin LX B series

- Rugged and reliable
- A good fit for wet process applications
- Multiple configurations available
- High-efficiency, single-stage pumps provide end vacuum levels comparable to most two-stage designs



Busch

[www.buschpump.com](http://www.buschpump.com)

### MV Visi®Trap Vacuum Pump inlet Trap

- Prevents users from contaminating a central source vacuum system
- Features clear 9.5" sumps for visually monitoring filter condition
- Can be supplied with replaceable copper or stainless steel gauze, molecular sieve, Sodasorb®, activated charcoal, activated alumina and Polypro 2-, 5- and 20-µm filter elements



Mass-Vac

[www.massvac.com](http://www.massvac.com)

### Rocker 500

- Provides vacuum and pressure in just one unit
- Has a noise level of only ~ 60 dB
- Maintenance-free because of the oil-free design
- Comes with guaranteed operation of two-years or 3000 working hours of free service parts (excluding the moisture filter)



New Star Environmental

[www.newstarenvironmental.com](http://www.newstarenvironmental.com)

## VACUUM PUMP MANUFACTURERS

**Agilent Vacuum Technologies** [www.chem.agilent.com](http://www.chem.agilent.com)

**Alcatel** [www.adixen.com](http://www.adixen.com)

**BrandTech** [www.brandtech.com](http://www.brandtech.com)

**Buchi** [www.buchi.com](http://www.buchi.com)

**Busch, Inc.** [www.buschpump.com](http://www.buschpump.com)

**Cole Parmer** [www.coleparmer.com](http://www.coleparmer.com)

**Ebara** [www.pumpsebara.com](http://www.pumpsebara.com)

**Edwards** [www.edwardsvacuum.com](http://www.edwardsvacuum.com)

**Gast Manufacturing** [www.gastmfg.com](http://www.gastmfg.com)

**Ilmvac** [www.ilmvac.com](http://www.ilmvac.com)

**KNF** [www.knf.com](http://www.knf.com)

**Mass-Vac** [www.mass-vac.com](http://www.mass-vac.com)

**Myers Vacuum** [www.myers-vacuum.com](http://www.myers-vacuum.com)

**New Star Environmental**  
[www.newstarenvironmental.com](http://www.newstarenvironmental.com)

**Oerlikon** [www.oerlikon.com](http://www.oerlikon.com)

**Pfeiffer Vacuum** [www.pfeiffer-vacuum.net](http://www.pfeiffer-vacuum.net)

**Precision Scientific** [www.precision-scientific.com](http://www.precision-scientific.com)

**Shimadzu** [www.ssi.shimadzu.com](http://www.ssi.shimadzu.com)

**Thermo Fisher Scientific** [www.thermoscientific.com](http://www.thermoscientific.com)

**US Vacuum** [www.usvacuumpumps.com](http://www.usvacuumpumps.com)

**VACUUBRAND** [www.vacuubrand.com](http://www.vacuubrand.com)

**Vacuum Research** [www.vacuumresearch.com](http://www.vacuumresearch.com)

**Welch** [www.welchvacuum.com](http://www.welchvacuum.com)

## VACCUBRAND® VARIO® self-regulating vacuum systems

VACUUBRAND® VARIO® vacuum systems offer users unsurpassed control of critical vacuum applications. A low maintenance chemistry-design pump is integrated with a variable speed motor and a mercury-free, digital controller. The system automatically finds and follows boiling curves, continuously optimizing the vacuum level without having to program presets. It's the ultimate productivity tool! All VARIO® vacuum systems have the performance features of VACUUBRAND chemistry-design

diaphragm pumps, like elimination of oil-changes, flowpaths constructed of corrosion-resistant fluoropolymers, integrated gas ballast and low-maintenance - typically 10,000-15,000 operating hours between scheduled service stops.

The VACUUBRAND PC3001 VARIO™ is the ideal vacuum system for benchtop sized rotary evaporators. The PC3001 VARIO runs your rotary evaporator with minimal supervision, freeing you up to do more important work. It features a VARIO version of the MD1C vacuum pump (2mbar ultimate vacuum), with integrated CVC3000 vacuum controller and solvent recovery in a compact, attractive package. The CVC3000 vacuum controller has an intuitive menu-driven graphic interface, with a "turn-and-push" jogwheel for quick adjustments.

- **Faster:** Because the vacuum level is continuously optimized, evaporation times are up to 30% faster when compared to other electronically-controlled pumps.
- **Easier:** Just press "Start" and the VARIO® pump begins pumping down, and finds the first boiling point. It maintains and continually optimizes vacuum levels to vapor flow — even for azeotropic mixtures!
- **Less "Babysitting":** The VARIO® controller automatically adjusts vacuum levels, reducing the need for manual adjustment or complex pumping programs. The pump even shuts itself off at pre-set levels or when evaporation is complete.
- **Virtually No Bumping:** The VARIO® controller automatically reduces the pumping speed as each boiling point is approached so "overpumping" is substantially reduced.
- **Less Maintenance:** Because the pump only operates enough to maintain optimum vacuum, wear is lessened, extending the service interval greatly.
- **GLP/GMP Validation:** An integrated bidirectional RS232 port allows control and monitoring of every parameter for process validation, and the execution of complex pumping programs.

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▲ PC3001 VARIO Vacuum System incorporates 2mbar, 1.0cfm chemistry pump with self-regulating electronic control and solvent recovery



▲ VARIO® control is also available as a pump/controller combination, without solvent recovery accessories for applications that already have integrated solvent recovery.

# MEASURING A CRITICAL PHYSICAL PROPERTY

Viscometers measure viscosity, the resistance of fluids to flow or stress. In common terms, viscosity is related to a fluid's "thickness"—a physical property of great interest to manufacturers of liquids, slurries, and pastes.

latter operate on the principle that energy must be applied to a spindle or disk rotating within a liquid to overcome the resistance of that liquid. That energy is proportional to the fluid's viscosity. Rotational

"Twenty years ago most users had an academic specialization in viscometry or rheology." Today, specialists have been replaced by generalists.

In biotech and pharmaceuticals, the viscosity of protein and buffer solutions constitutes one of numerous quality checks; in beverages, viscosity is an indicator of sugar content and overall quality. Polymer scientists use viscosity to determine the concentration of plastics in acid solutions.

**"While manufacturers continue to fine-tune more-sophisticated electromechanical rotational viscometers, the underlying technology hasn't changed much."**

Viscosity is a critical characteristic of foods, paints, cleaners, adhesives, polymers, fuel oils, and pharmaceuticals. Many industries use viscosity as an endpoint in the manufacture of liquid-formulated products.

Dozens of viscometer types are in use in academia, industry, and basic research, and cost from about \$100 for simple mechanical viscometers to \$15,000 automated instruments. Rheometers, which measure viscosity and related properties, may cost as much as \$200,000.

At the low end of the price range are U-tube and Cannon-Fenske tube viscometers found in schools, colleges, and some industries. Other simple designs include falling sphere, falling piston, rolling ball, and oscillating piston viscometers. These are not instruments in the truest sense; some require pourable fluids.

More sophisticated are vibrational viscometers used in process industries, and rotational viscometers. The

viscometers do not require that the testing sample be pourable.

Higher-end viscometers may be connected to and operated through a computer, or readouts may be taken directly off the front panel display. Some industries favor one viscometer type. Paint and pigment industries prefer the Stormer viscometer, which uses paddles on a rotor submerged into the product. Similarly, resin labs use bubble viscometers, which measure the time it takes a bubble to emerge from varnishes, and petrochemical companies prefer the Stabinger viscometer, which employs a rotating cylindrical tube.

Viscometry is an old technique, but while manufacturers continue to fine-tune more-sophisticated electromechanical rotational viscometers, the underlying technology hasn't changed much.

What is different, says Steven Colo, president at ATS RheoSystems (Bordentown, NJ), is user expertise.

Viscosity measurements are usually conducted on dilute solutions and at varying concentrations. Measurement of the viscosity of polymer solutions at different strengths, for example, provides estimates of secondary properties such as intrinsic viscosity, molecular weight, and chain length.

Viscosity is related to solute concentration, making it one of the most useful physical measurements in research and product development. The viscosity of a liquid tends to rise with the concentration of solid solutes, as with sugar in water. But the viscosity of a blend of fully miscible and non-reacting liquids is usually somewhere between the viscosities of the components.

Useful viscometer/rheometer features that buyers should be aware of are temperature control, spindle rotational speed control, a range of sample holders, and ease of use.

## RECENTLY RELEASED VISCOMETERS

### SVM 3000

- Measures dynamic viscosity and density of oils and fuels according to ASTM D7042
- Automatically calculates the kinematic viscosity and delivers measurement results which are equivalent to ISO 3104 or ASTM D445
- Processes up to 30 samples in an hour



www.anton-paar.com

Anton Paar

### µVISC™ (micro VISC)

- Supports testing of higher viscosity ranges up to 20,000 mPas or higher
- Provides for easy and rapid viscosity measurements and now supports a wider range of applications
- Features a simple 1-2-3 step operation, which allows tests to be completed within a minute



RheoSense

www.rheosense.com

### Black Pearl Rotational

- Performs both routine rheological tests and complex rheological evaluation
- Comes standard with built-in Peltier temperature control for all measuring systems
- Measuring systems employ novel "Quick Capture" mounting technology
- Features an angular velocity range from 0.01 to 200 rad/s, a torque range from 0.005 to 20 mNm and a temperature range from -10° to 120° C



ATS RheoSystems

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### SpectroVisc Q3000

- The world's first truly portable, solvent-free, temperature-controlled kinematic viscometer
- Allows the user to measure kinematic viscosity from only a few drops of oil
- Requires no solvents for cleaning
- Entire sampling and testing process takes only a few minutes
- Weighs just under 1.8 kg



Spectro

www.spectroinc.com

## VISCOMETER MANUFACTURERS

A & D Weighing	www.andweighing.com
Anton Paar	www.anton-paar.com
ATS Rheo Systems	www.atsrheosystems.com
Brookfield Engineering	www.brookfieldengineering.com
Cannon Instrument Company	www.cannoninstrument.com
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# TO CENTRALIZE OR NOT TO CENTRALIZE?

Whether to employ central washing stations or point-of-use washers located under a lab bench is something that has to be addressed with regards to laboratory glassware washers. The former provide an economy of scale and are popular with lab workers who, almost universally, hate to “wash the dishes.”

The downside for central washing stations is that glassware tends to disappear over time, due to breakage and operator error. Nobody cares if they lose a beaker or Erlenmeyer flask. The problem arises with specialty glassware such as distillation heads or Soxhlet extractors, or custom-blown glassware, which is expensive and can take days and many dollars to replace.

Jenny Sprung, a product manager at Labconco (Kansas City, MO), notes that washing stations can take a while to return glassware. “Central glassware washing is great in principle, but if you rely on it and the person in charge of collecting glassware and running the washer is out, you can have a very long wait.”

Point-of-use washers provide a level of control that central stations do not.

Workers can, for example, set the machine to run overnight and then return to a set of sparkling glassware the next day.

Two other situations suggest the superiority of point-of-use washing. Laboratories handling diluted, highly sensitive samples, or whose analytic methods are extremely sensitive, might not tolerate residues left behind by cleaning products — whether they be detergents or chemical agents. It should be noted, however, that leading

carded as waste, while hand-washers tend to over-apply cleaning agents and almost always leave residues. Finally, glassware that is manually dried might require an extra autoclaving step for sterilization.

“To determine the best option for your lab, you need to carefully analyze these factors, plus the ongoing cost of hand washing vs. the acquisition of a glassware washer that will last years after the initial purchase,” Ms. Sprung says.

Mike Henley, general manager at LANCER (Winter Springs, FL), adds local, factory-trained service, and maintenance agreements to the list of

**“A well-designed lab washer can potentially save hundreds or thousands of dollars a year.”**

machine manufacturers claim their washers leave behind as close to zero residue as possible.

Radioisotopes are rarely used for analysis these days, but if your lab employs them, you might consider keeping associated glassware away from any washers to avoid permanently contaminating the machine and cross-contaminating subsequent loads.

Hand washing might make economic sense for very “clean” workflows that include foods and beverages, but it too has drawbacks. As Ms. Sprung points out, acidic and alkaline baths must be properly neutralized or appropriately dis-

desirables for a lab washer. He says that remote diagnostics are more frequently used today as a means of documenting outages and alarms, to prevent service calls in some cases, and to maintain the life of the machine and reduce downtime.

“The choice also depends on building design and [how much users need to] minimize the consumption of water and electric utilities,” says Mr. Henley.

A well-designed lab washer can potentially save hundreds or thousands of dollars a year in electricity and water, generating a full ROI in five years.

## The PG 8536: The Perfect Solution for Cleaning Petroleum Compounds.

Petroleum compounds, such as refined hydrocarbon distillates, are generally a difficult-to-clean, oily, molasses-like substance. Traditionally, these compounds are cleaned using hydrocarbon solvents such as diesel fuel; however, this process can be hazardous to personnel and can create environmental disposal problems. In addition, some solvents are illegal due to

ozone depleting effects — and flammable solvents can only be used in a Class I, Division II explosion-proof area. Converting to an aqueous-based method can eliminate all of these concerns and will be less costly. The question is: Will an aqueous system clean as effectively as a solvent-based system? The answer is yes. Miele's PG 8536 is the perfect solution.

Effective aqueous cleaning is based on a balanced interaction of four important factors:

### TEMPERATURE:

In general, hotter water provides better cleaning and rinsing. Miele washers can heat wash and DI water up to 95°C. Additionally, wash and DI water temperatures are independently adjustable on Miele systems for maximum flexibility. For cleaning of petroleum based compounds a wash temperature of 95°C is recommended, followed by a DI rinse with acid neutralizer, then one or two DI Rinses heated to 95°C.

### MECHANICAL ACTION:

It is often assumed that high pressure must be used to provide good cleaning results, but higher pressure also means a greater chance of glassware breakage. Miele's high turnover rate (circulation) of water at a low discharge pressure provides superior results without risk of glassware breakage. Using only 2.5 gallons of water per cycle, the Miele PG 8536 glassware washer circulates at a rate of 156 gallons per minute. This compares with 25 gpm for typical household dishwashers and 60 gpm for typical lab washers. Miele's high circulation rate ensures analytically clean results; reduces wash time required, aids in energy efficiency and allows for lower detergent usage. The Miele lower spray arm also features special spray nozzles which angle and feather the jet spray for maximum coverage and impingement.

### TIME:

Most labs cannot spend the time waiting for a washer to complete long cycles. In addition to high circulation rates providing faster cleaning, The PG

8536 utilizes only 2.5 gallons of water per cycle, which is heated by 6000 watts of power at 220 V. This means less time is wasted waiting for water to be heated to temperature. For cleaning of petroleum compounds, a longer wash cycle may be necessary. The wash time on the Miele PG 8536 is programmable, making it flexible for customized washing protocols.

### DETERGENT:

Selecting proper detergents is an important step in achieving critically clean glassware. Miele offers an extensive line of powder and liquid detergents, and acid neutralizers. For petroleum compound applications, liquid detergent, neodisher® FLA has proven effective in combination with an acid neutralizer, and neodisher EM emulsifier- to aid in suspending hydrophobic hydrocarbons in solution.

### OTHER CONSIDERATIONS

Because of the nature of petroleum compounds, the door and sump pump seal are likely to deteriorate quickly, causing leaking. Miele utilizes grease resistant NBR polymer gaskets which are chemically resistant to petroleum compounds. The thick nature of these compounds can also cause sump filters to become clogged — but Miele's triple filter system is easily removed for cleaning. In some instances, Miele's wash protocol includes an extra wash cycle simply to “de-gunk” the washer.



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PROFESSIONAL

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- SteamScrubber® series provides top and bottom racks that accommodate accessory inserts for a wide variety of glassware shapes and sizes
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- The FlaskScrubber® Vantage® series includes additional monitoring and control features



Labconco  
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**1700 LXA**

- Available in single- or double-door configurations for pass-through applications
- Features high-capacity cleaning with up to three levels of washing
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- Features continuous conductivity monitoring for residue-free rinse quality

Miele  
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Labconco Glassware Washers offer more options and flexibility than ever before, including:

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- Interchangeable racks to handle narrow neck and wide mouth glassware
- Programmable water temperatures to 93° C
- Forced air drying up to 99 minutes



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# UNDER-RECOGNIZED 'UTILITY' ESSENTIAL FOR LABORATORY OPERATIONS

Laboratory water purification systems get no respect. They're used every day, but few lab workers realize—beyond opening the spigot—how they operate.

"The level of knowledge in the average lab about lab water is not very high," says Julie Akana, Ph.D., product manager for water purification products at Thermo Fisher Scientific (Ashville, NC).

**"The lesson here is to monitor water, even ultrapure water, for as many contaminants as is practical."**

Pure water is classified, in order of decreasing purity, as Type 1, Type 2, and Type 3. Culture media, clinical laboratory analyzers, and buffer preparation get by nicely with Type 2 water, which also serves as feed-stock for Type 1 purification systems. Labs use Type 3 "pure" water for labware washing and rinsing and for heating and cooling devices in which mineral deposits from circulating water are a problem.

Common techniques for water purification include distillation, filtration, deionization, electrodeionization, reverse osmosis, adsorption, and ultraviolet oxidation. Distillation is the oldest method and the broadest in terms of impurity removal, but even

the best stills produce "only" Type 2 water, and reverse osmosis systems, Type 3. Stills (including double- and triple-stills) are still quite common because of their simplicity and the fact they require no consumables.

Nick Papp, president of Aqua Solutions (Jasper, GA), describes distillation as "dead but refusing to get buried." Distillation includes high energy costs and maintenance

and rapid degradation of the product.

Most single purification methods excel at

one type of removal, e.g., ions, organics, or particles, and individually produce water intermediate between Type 1 and high-end Type 2. Ultrapure water systems combine several of these techniques.

For example, in a high-end ultrapure water system, tap water feeds through a reverse osmosis membrane, then into deionization cartridges, an ultraviolet cell to destroy bacteria and oxidize organics, an activated carbon cartridge to remove the organic by-products of the UV step, and an ultrafiltration membrane to remove pyrogens and nucleases.

Because of budget cuts, institutions are avoiding centralized, shared-resource water purification systems.

The paradox is that such systems are probably the most cost-effective, albeit capital-intensive. As a result, business is booming for smaller units suitable for a single lab or group.

"Trends in pure water systems are driven by the capability of analytical instrumentation to detect lower and lower levels of contaminants," observes Papp. "We've essentially gone from part-per-million detection to part-per-billion, so more people are demanding purer water."

Users, he says, should pay special attention to what they're using the water for and what species might interfere with their analyses.

Estelle Riche, Ph.D., an applications scientist at EMD Millipore (Billerica, MA) warns about "emerging contaminants" in tap water and their potential impact on ultra-pure water used in laboratories. Those include common prescription and over-the-counter pharmaceuticals, caffeine, herbicides, pesticides, flame retardants, and components of personal-care products.

Given the sensitivity of modern analytical instrumentation, Dr. Riche wonders, "Are these contaminants making their way from the tap into the high purity water used in the laboratory?"

The lesson here is to monitor water, even ultrapure water, for as many contaminants as is practical, and not take conductivity readings as the final arbiter of purity.

## PURELAB flex- innovating water purity

ELGA's new innovative Type I ultrapure water purification system ensures accurate consistent results. The PURELAB flex 3 & 4 are the latest additions to the award winning PURELAB flex range of systems. Both systems deliver up to 10 liters of ultrapure water per day and up to 2 liters per minute. The PURELAB flex 3 delivers ultrapure water direct from potable tap water and PURELAB flex 4 requires a pre purified feed.

The PURELAB flex offers many advantages for analytical and lifescience applications. It allows users to focus on routine test work, without having to worry about the water quality affecting any test results. The PURELAB flex 3 and 4 are flexible water purification systems which can be adapted to respond to a laboratory's changing water purity needs today and tomorrow.

The water quality conforms to international water standards e.g. CLSI, CLRW, ISO 3696: Grade 1,2,3, ASTM D1193-06, Pharmacopeia USP, EP and JP. The PURELAB flex can be used for analytical and lifescience applications in all pharmaceutical, university, hospital, food and beverage laboratories.

The PURELAB flex is easily adaptable to facilitate changes to laboratory design layouts and applications.

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- Intuitive to use
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- Clear water purity for absolute confidence as you dispense
- Handset displays prioritized information shown at all times (system status, TOC, alarm)
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  - o Autovolume dispense from 50ml to 60ml and repeat dispensing
  - o Hands free with optional foot pedal
  - o Locked dispense for glassware filling

### Water Purification made easy

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WaterPro® PS Polishing Stations

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How EMD Millipore Water Systems Let Work Flow in the Laboratory

In today's challenging economy where laboratories are being asked to "do more with less," lab personnel are looking for ways to improve productivity. One often overlooked place to start is the water purification system found in almost every lab. Water is the most frequently used laboratory reagent. The quality of the water used in labs has a profound effect on all phases of life science and analytical analyses and on lab productivity.

For example, a lab working with yeast cell cultures in southern France observed that the cultures often died before experiments could be completed. The same laboratory experienced poor reproducibility for western blotting and PCR procedures. In both situations, the problem was solved when the water purification system was replaced by a Milli-Q® Integral system, which delivers adequate water quality thanks to the use of proprietary water purification and monitoring techniques. In the U.K., a medical device research lab found that having a constant supply of pure and ultrapure water from a Milli-Q Integral allows researchers to gain time and focus on their work. Water can be dispensed automatically, and no one is obliged to interrupt their activities and wait for containers to fill.

Designed with laboratory productivity in mind, water purification systems from EMD Millipore take into account problems such as those described above. The company's flagship Milli-Q Integral is a "2-in-1" water purification system that puts pressurized pure and ultrapure water — produced from tap — at users' fingertips. The system's convenient POD (point-of-delivery) dispensers allow manual or automatic water delivery; height and flow rate are both adjustable. In addition, integrated Elix® electrodeionization technology ensures consistent high water quality at a low operating cost.

A highly satisfied flow cytometry core facility lab manager recently described her own experience with the system: "The Milli-Q Integral system has decreased my cost to do business. I'm filling large volumes on a regular basis — often ten liters at a time. With the high flow rate offered by the Integral system, I don't have to wait all day for the carboys to fill."

"I integrated one of the POD dispensers directly into a system that automatically mixes the water from the Integral with a 10x buffer solution. The core lab used to purchase prepared 1x buffer which is quite expensive, and delivery was often unreliable. I did a simple cost analysis and it was clear — making the 1x buffer myself using the Integral system decreased my cost of doing business. The system will pay for itself in a year."

To read about the similar experiences of other Milli-Q Integral system users, or for more information, just visit our web site: [www.millipore.com/labwater](http://www.millipore.com/labwater)



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## The Soil-XCell System from Environmental Express

### Revolutionizes Soil Extraction for Organics



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Web: [www.environmentalexpress.com](http://www.environmentalexpress.com)

#### AN ALTERNATE METHOD OF SOIL EXTRACTION FOR EPA METHOD 3546

Environmental Express, known for its innovative products, has developed the Soil-XCell system for the extraction of semi-volatile organic compounds in soil samples. The Soil-XCell system meets the requirements EPA SW846 Method 3546 and replaces microwave technology with a HotBlock and stainless steel Soil Extraction Cells. Analytical results of a CRM (Certified Reference Material) for PAH/BNA and TPH fell within the required acceptance limits and were very reproducible. Real world soil samples were also extracted using this procedure for PAH/BNA, TPH, and PCB compounds and compared to results achieved using SW846 Method 3545A. Results were comparable for all three groups of compounds.

Method 3546 is a procedure for extracting water insoluble or slightly water-soluble organic compounds from soils, clays, sediments, sludges, and other solid wastes. The method was originally developed to use microwave energy to accomplish a static solvent extraction using an elevated temperature of 100 - 115°C and an elevated pressure of 50 - 175 psi. Method 3546, however, does allow for the use of alternative systems to provide the elevated heat and pressure required to successfully extract the organic compounds from the sample. In addition, the EPA supported performance-based measurement system (PBMS) also allows for the use of alternative systems and vessels as long as the desired target analyte sensitivity and recovery requirements are met. Environmental Express has gathered data for the extraction of organic compounds based on the heat and pressure requirements of Method 3546 using the HotBlock and Soil Extraction Cells (stainless steel cells). Visit our website at [www.envexp.com](http://www.envexp.com) to view the technical write up.

#### Soil-XCell Extraction Procedure

- Weigh out 10 - 30 g of soil into each of the Soil Extraction Cells. May vary depending on laboratory needs.
- Add approximately 30 mls of solvent to each cell.
- Place the stainless steel inner lid with o-ring onto each extraction cell.
- Hand-tighten the threaded outer cap onto each extraction cell.
- Heat your HotBlock to 130°C. This will yield an internal temperature of 100 - 115°C which is required by Method 3546.
- Put the Soil Extraction Cells in the HotBlock and heat for 30 minutes at a block temperature of 130°C. This will give samples 10 - 20 minutes at the appropriate temperature for extraction which is recommended by Method 3546.
- Remove the cells and allow them to cool to room temperature.
- Unscrew the threaded outer cap and remove.
- Take out the stainless steel inner lid and rinse with solvent, taking care to collect this rinsate in the cell.
- Proceed with filtering and rinsing, collecting all filtrates. A Buchner funnel with vacuum is recommended.
- The extract is now ready for concentration, cleanup, and analysis.



## Maximizing UV light for Lab Water Systems



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**Abstract:** Conventional lab water systems use UV light by flowing water in a chamber around the bulb in a protective quartz sleeve as part of the recirculation loop. Using innovative technologies, the UV light benefits are maximized but sterilizing the water in the loop and the dispensing port as well.

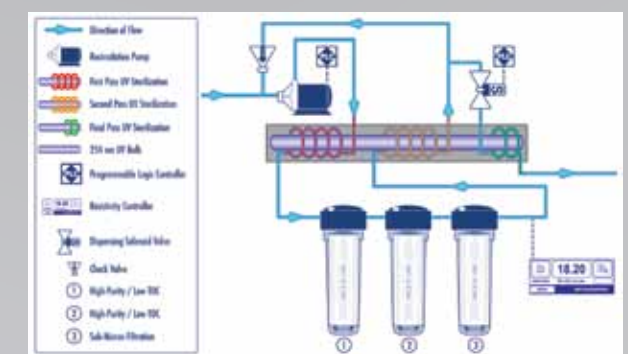
**Introduction:** For many years, the water industry has known the many benefits of ultraviolet (UV) light for germicidal reduction. The specific wavelength of 254 nm destroys the nucleic acids of the bacteria's DNA rendering it sterilized and prevents the colony from growing.

In most lab water systems today, UV systems are installed as a single pass within the recirculating loop. Water flows around a UV bulb in a quartz sleeve sterilizing the purified water. To dispense the water, an automated or manual valve is opened and flow will enter a 0.2 micron capsule filter upon exit. As the system sits idle, a potential for bacteria growth exist on areas outside of the recirculating loop: post valve tubing and submicron filter. Most manufactures recommend flushing water through the filter before use to purge the small standing water. To bring awareness of this potential issue, ASTM 5196 Biomedical grade specification, Section 4.5 addresses the dispensing port:

*The distribution outlets or faucets must be of non-contaminating design and materials. Particular care must be given to the valve seat and joint construction. The outlet must be protected from biological contamination particularly when the use is only occasional. Ultraviolet (UV), chemical, or heat sterilization should be considered.*

An innovative approach for UV sterilization has been developed to irradiate the water at multiple passes within the recirculating loop. By taking a UV bulb in an atmospheric, shielded box, Teflon coiled tubing wraps around the UV bulb with a turbulent flow and maximizing surface area irradiation. Water is UV irradiated before deionization, after DI and submicron filtration, and the outlet dispensing port thus meeting the ASTM 5196 specification for Biomedical Grade Water. The Aries Filterworks Gemini system with multi-pass UV was tested with a bacteria challenge.

**Experiential Conditions:** A pure strain of *Pseudomonas aeruginosa* was inoculated into a flask and incubated for 24 hours. Following incubation, enumeration was performed using diluted spread plate technique. The culture was determined to contain  $2.0 \times 10^9$  cultivable bacteria per ml using *Pseudomonas* Isolation Agar (PIA).



Following introduction of the challenge organisms, the Gemini was allowed to recirculate for one minute. After recirculation, three samples were dispensed from the Gemini outlet and collected in 1 liter autoclaved bottles. This procedure was repeated for samples collected at 30 minute and 1, 2, 3, 4, 24 and 48 hour post spike injections. No other water was dispensed from the Gemini unit during the test period. Following incubation for 24 hours and five days, bacteria on the plates were enumerated. The Gemini panel resistivity meter reading was noted and the dispensing UV lamp was checked at each sampling.

**Results:** During the test period, the Gemini resistivity was equal to or greater than 18.1 megohm-cm @ 250 C. The UV lamp at the dispenser port was operating during each sample event. No viable bacteria were discovered from any of the triplicate 1 liter Gemini outlet samples collected 0 to 48 hours following a *P.Aeruginosa* spike

Samples collected twenty eight days after the spiking of the Gemini feed water with  $2 \times 10^{10}$  *Pseudomonas aeruginosa* bacteria cells and analyzed by the Kinetic Turbidimetric Method, was also completed for pyrogens with less than 0.003 EU/mL

**Conclusions:** Using the non-conventional methods of UV sterilization in a multi-pass arrangement provides the user with confidence that the dispensing port has not been compromised with bacteria growth. The Gemini ultrapure water system use of UV, deionization, and submicron filtration provides consistent, reliable Type I and Biomedical grade water.

**References:** ASTM D5196 - 06 Standard Guide for Biomedical Grade Water

# DELIVERING FLUIDS CONTINUOUSLY AND PRECISELY

Automated liquid handlers (ALHs) are one of the truly enabling technologies of modern life sciences, particularly in medical testing, biological research, and high-throughput screening. Applications in combinatorial chemistry and materials investigations were considered emerging a decade ago, but these markets remain small.

Liquid handlers use robotically controlled pipettes to deliver precise quantities of liquid reagent to reaction vessels, often to microtiter plates.

**“True walkaway automation is also increasing in importance along with the ability to track and monitor samples.”**

“Automated” is the functional word in ALH markets. Once a method is entered, robots are expected to deliver fluids continuously and precisely (both in terms of location and quantity), with extremely high reproducibility, often nearly continuously.

Manufacturers of ALHs are feeling pressure to simplify, to offer products that resemble workstations rather than stand-alone instruments. “That doesn’t mean they want simplified capabilities,” says Isaac Meek, technical specialist at Caliper Life Sciences (Hopkinton, MA). “They want the features and functions, but they also want to be productive without having to be programming experts.”

Caliper and other vendors therefore “encapsulate” or standardize methods to liquid handler configurations, thus multiplying the instruments that can benefit from specific methods.

Another significant trend is shrinking instrument size and discrete systems. “Users want desktop-sized instruments that will not interfere with other equipment,” Mr. Meek says. With more-compact footprints have come software improvements that positively affect usability.

True walkaway automation is also increasing in importance along with the ability to track and monitor samples as they wind through the workflow. Pipetting accuracy and calibration, which go hand in hand, are significant operations or features, depending on one’s perspective, in automated liquid handling.

Calibration is usually done gravimetrically, but the weakness of this approach is that by weighing the entire plate (the standard method), one obtains the average volume delivered but no inkling of tip-to-tip variability.

“When we introduced our first liquid handler in 1990 for emerging high-throughput screening applications, there was greater concern for coefficient of variation than for

absolute accuracy,” says Tom Astle, president of Tomtec (Hamden, CT). “Users wanted and expected all samples to be the same. Today, with the emphasis on bioanalysis, accuracy is king.”

Issues in delivery accuracy vary depending on the type of displacement used. Air displacement, which uses disposable tips, creates the most pipetting variation, according to Mr. Astle.

With positive displacement pipetting, the piston plunges to the bottom of the tip’s orifice, so there is no air gap or dead air volume that can affect dispensing. Positive displacement delivers superior tip-to-tip reproducibility, Mr. Astle says, but it requires tip cleaning, another possible source of error.

Mr. Meek mentions three factors that buyers should consider when shopping for an automated liquid handling system:

- Software versatility and ease of use: How easy is it to learn? Does the instrument come with useful software content or methods? How steep is the learning curve?
- Instrument size and configuration: Liquid handlers should not require special tables or space, or dedicated hoses or power supplies.
- Flexibility, expandability, and ability to integrate with other systems if needed. These benefits are important if labs expect increased throughput needs or if methods change.

## Hamilton’s MICROLAB® REM e STARlet

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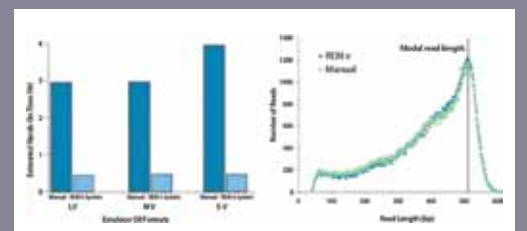
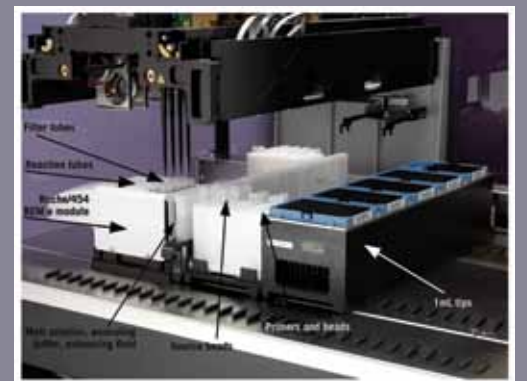
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Hamilton’s **MICROLAB® REM e STARlet** liquid handling workstation (Figure 1) provides a completely automated solution for emPCR enrichment and sequencing primer hybridization. Designed to support the Roche/454 Genome Sequencer FLX Titanium Series System, the **REM e STARlet** features 8 independent 1ml pipetting channels, associated labware racks/carriers and an integrated Roche/454 REM e module (Figure 2). The turn-key solution includes five performance-verified protocols for large, medium and small volume samples, providing convenient walk-away automation for streamlined workflows, higher throughput and enhanced reproducibility when compared to manual processing.

The Roche/454 Genome Sequencer FLX System is a versatile sequencing platform suitable for a wide range of research applications, including de novo sequencing and assembly of genomic DNA, transcriptome sequencing, small RNA analysis and amplicon sequencing.

The Genome Sequencer FLX workflow consists of three primary processes: library preparation, emPCR amplification and sequencing. The REM e module is a self-contained, multi-functional liquid handling accessory capable of vortexing, vacuum filtration (no centrifugation required), magnetic bead capture and heating to 65°C. The device is designed to automate the enrichment and sequence primer annealing steps of the GS FLX Titanium emPCR process. When integrated to the purpose-built **MICROLAB REM e STARlet** pipetting workstation, the system dramatically simplifies the emPCR workflow by replacing 5 hours of dedicated manual lab work with a fully automated walk-away procedure. (Figure 3)

Data from various sample types and formats processed on the **REM e STARlet** workstation demonstrate achievement of sequencing results comparable to those of manual emPCR enrichment. (Figure 3) The enrichment data along with the sequencing data (not shown) confirms that the system is capable of performing emPCR enrichment with results that are consistent with expectations. The **MICROLAB REM e STARlet** significantly decreases the amount of hands-on time necessary to perform sequencing, and minimizes errors attributed to manual mispipetting.





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# LabWrench

Lab Equipment Information and Discussions.

# THE ROBOTIC GLUE FOR MICROPLATE APPLICATIONS

Experimentation in microtiter plates exemplifies the two dominating trends in the life sciences: higher throughput and smaller sample size. Microplate handlers are the robotic glue that connects microplate readers, liquid dispensers, plate storage systems, plate washers, and other equipment essential for microplate-based research and development. Handlers transfer plates between and among these components to allow semi-automated to fully unattended assays.

Microplate handlers range from linear, benchtop models to more complex instruments with articulating arms. Linear handlers can integrate with between two and four adjacent instruments, such as liquid handlers, bulk liquid dispensers, centrifuges, incubators, microplate readers, labelers, or sealers. More complex microplate handlers with articulating arms have a larger, cylindrical work envelope and can automate more sophisticated laboratory workflows within contained, environmentally controlled environments. Traditional microplate-based applications include drug discovery, cell-based screening, and compound management. A rapidly emerging application is automated microplate-based sample preparation for next-generation genetic sequencing.

In the early days, microplates varied in size and dimensions. Today they conform to Society of Biomolecular Sciences standards; this allows any

handler to process virtually any plate.

While many labs still transport plates manually, robotic handlers have become essential for high-throughput applications such as drug screening and medical diagnostics. Handlers have also found applications in materials, environmental, and forensics laboratories, and in low- to medium-throughput work where unattended operation is desirable.

Automation requirements vary widely among users of microplate

within biosafety cabinets, demand for small-footprint handlers is strong.

Flexibility relates to how, and how much, a plate handler interacts with surrounding equipment and processes, but there's a price point component as well. With entry-level microplate handlers costing \$20,000 or more, "users want the greatest functionality they can get for their budget," Ms. Buehrer notes.

"Potential buyers should consider the speed, expandability, software

compatibility, and space requirements of microplate handlers," says Dino Papoutsis, senior product manager at Agilent (Santa Clara, CA).

Labs planning for a variety of assays or assays of increasing complexity may consider articulating arm handlers with a larger work envelope to enable integration with a larger number of devices.

Scheduling software is a critical component of automated microplate handling. To facilitate workflows, software should be compatible with a wide variety of instruments. Purchasers should also carefully consider the space requirements for microplate handling devices, as space requirements vary from modular benchtop models to standalone containment-based systems.

instrumentation, and many potential users demand flexibility. "Some laboratories need total control of all their microplate-based assay processes and use major robotic handling systems," says Lenore Buehrer, product manager at BioTek Instruments (Winooski, VT). "Others need semi-automated systems where a single process, like dispensing, is automated but the plates are then manually transferred to the detection systems. These users are content with using the plate handler for just one or two operations."

Automation, flexibility, throughput, software, and instrument size are factors potential buyers should consider when acquiring a plate handler. Size is always a consideration for labs short on space. But with many users installing plate handlers

**"Automation, flexibility, throughput, software, and instrument size are factors potential buyers should consider when acquiring a plate handler."**

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- Ensures operator safety with its unique twin-button operation



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# EVOLUTIONARY CHANGES BRING GREATER FUNCTION, FLEXIBILITY

Although a mature product category, microplate readers are evolving towards greater functionality, flexibility, and throughput. All top instrument makers are focusing at least some efforts on multiplexing.

“Vendors are introducing evolutionary improvements in performance, reliability, user interface, and support,” says Xavier Amouretti, product manager at BioTek Instruments (Winooski, VT).

Users, according to Mr. Amouretti, expect a short learning curve, user-friendly software, and instrument reliability.

When plate densities were increasing during the last decade in response to very high-throughput studies, it appeared that plate readers would require upgrades as well. Luckily, experiment densities have stabilized, with life science researchers turning to smaller, “smarter” screens. 384-well plates have become standard in industry, while 96 wells is quite common in academic research.

However, the desire to consume less sample and fewer reagents continues. BioTek has developed the Take3 Micro-Volume Plate accessory that works on principles similar to Thermo’s NanoDrop UV/Visible analyzer. After depositing 2 µL samples on the 16- or 48-spot plate, the second optical surface engages, and the plate is read in the standard manner.

Not that ultra-dense plates are completely out. “The emergence of the 3456-well format has created demand for screening an entire compound library on one plate,” says

Dr. Michael Fejtl, international sales and marketing specialist at BMG Labtech (Ortenberg, Germany).

One indication of the maturity of the plate reader market is the number of vendors involved, more than 25 in the United States, according to the *Lab Manager* website. With so many vendors competing for modestly growing research and high-throughput markers, there has

“With so many vendors competing for modestly growing research and high-throughput markers, there has been a steady stream of technologic innovation and price reductions.”

been a steady stream of technologic innovation and price reductions.

An example of such innovation is Douglas Scientific’s (Alexandria, MN) ArrayTape. Instead of an injection-molded plastic microtiter plate or microarrays, the product is a continuous polypropylene (or polystyrene, polycarbonate) strip embossed with reaction wells that hold less than 800 nL of test fluid. Wells are arranged in familiar SBS format (96, 384, 1536, etc., wells), but the savings in reagent and solvent are as much as 90 percent compared with standard microwells.

Anita Kant, Ph.D., application scientist at Molecular Devices (Sunnyvale, CA), has compiled a list of things to look for in a microplate

reader. These include specific applications, the number of expected users, sensitivity, current vs. future needs, system versatility, and single vs. multimode reading capability.

To these, Dr. Fejtl adds upgradeability and multiplexing. “It should be easy to employ different detection technologies such as absorbance and fluorescence in a single experiment,” he says.

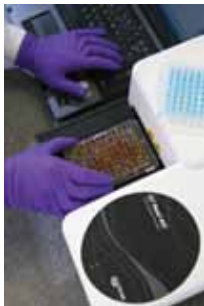
“Single mode is less expensive, but that may not satisfy future needs,” says Dr. Kant. Nevertheless, multi-mode (and some other) capabilities may be added later on, provided the instrument can handle upgrades.

Users are also big on ease of use, reliability, robustness, validation capabilities, throughput, automation, and service. Ease of use includes the user interface and software; validation capabilities, once solely the domain of environmental, forensics, and pharmaceutical labs, are gaining popularity among non-regulated industries as well. Automation and throughput are significant factors for medium- to high-throughput labs, but not to academic and basic research organizations.

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BMG Lab Technologies

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## MICROPLATE READER MANUFACTURERS

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# ONE OF BIOLOGY'S MOST USEFUL TOOLS

Within a decade of its discovery in 1983, polymerase chain reaction (PCR) evolved into one of biology's most useful tools. PCR amplifies specific segments of genes so accurately that an early National Institutes of Health publication dubbed the technique "Xeroxing DNA." Today, PCR is used routinely in dozens of approved medical tests in diagnostic labs and physician offices, and by millions of scientists worldwide.

**"Purchase decisions for PCR reagents are based on performance (speed of analysis, fidelity of DNA-copying) and price."**

Understanding PCR reagents requires a bit of knowledge about the reaction itself. The steps involved in PCR are:

- **Denaturation:** Heating the sample to separate the target DNA's double helix into individual strands. Denaturation takes place in specialized buffers.
- **Annealing:** Cooling the sample in the presence of an "antisense" (or complementary) DNA sequence, known as a primer (there are two primers, one for each strand separated in the first step).
- **Elongation:** Addition of an en-

zyme, polymerase, that builds the new DNA strands, and deoxynucleotide triphosphates (dNTPs), which are building blocks for the new DNA copies.

These steps repeat 30 or 40 times in a thermocycling instrument. Each step doubles the quantity of DNA produced.

Each of the steps involves specific reagents that are general for all PCR experiments: TRIS or some other buffer, enzyme, magnesium chloride (necessary for enzyme activity) and the dNTPs. Primers and templates are unique for every amplification. Since the patents on Taq polymerase expired, vendors have been free to develop

and sell their own versions, resulting in downward price pressures.

PCR reagents are sold individually or as "master mixes." The separate purchase route allows end users to fine-tune PCR reactions with favored (or less expensive) reagents, but this requires a fair degree of expertise. The debut of "real-time" or "quantitative" PCR (qPCR) allows investigators to quantify the number of copies made and, by backtracking, the concentration of the template in the sample.

Purchase decisions for PCR reagents are based on performance (speed of analysis, fidel-

ity of DNA-copying) and price.

Instruments used to play a role in choice of reagents, says Jeff Williams, Ph.D., president of Lucigen (Middleton, WI), but "these days temperature cycling instruments have fairly similar performance characteristics and should not be a factor in reagent selection."

Recently, environmental scientists detected the presence of Asian carp in the Great Lakes—not by capturing a fish, but by amplifying their genes with PCR. Similarly, beer brewers use PCR to uncover bacterial contamination in their process. PCR may also be used at relatively large scale to manufacture genes for gene therapy or vaccine work.

One instrument-related issue that still concerns analysts is temperature. Specialized experiments may require reaching precise temperatures for exact times. "The wrong temperature can cause amplification of the wrong DNA segment," notes Ms. Mason of Agilent, who believes that instrumentation is "lagging behind" reagents in terms of speed and quantity of DNA produced, particularly with multiplexing (several samples in one run) becoming more common. "Screening experiments don't have to be as precise as quantitation. It depends on what you're trying to achieve with a particular amplification."

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SPEX CertiPrep offers a line of Consumer Safety Compliance Standards designed for the testing of consumer goods. Recent regulations limit the quantities of toxic contaminants in consumer products, requiring manufactures to verify the levels of trace impurities in their products. RoHS/WEEE regulations restrict the levels of heavy metals in consumer goods and electronics. USP 232 has been enacted to control the levels of elemental impurities in pharmaceuticals. Additional regulations control the levels of a variety of metals and phthalates in plastics and children's products. SPEX CertiPrep has developed a line of Compliance Standards designed to assist the analyst in testing for these specific regulations.

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Bulldog Bio	www.bulldog-bio.com
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# HELPING TO “KNOCK DOWN” GENES

RNA interference (RNAi) uses short strands of synthetic ribonucleic acid (RNA) to silence or “knock down” genes implicated in certain phenotypes—most commonly (but not limited to) diseases.

The “interference” occurs when interfering strands bind to complementary, naturally occurring RNA according to standard base-pairing rules. Unlike antisense technology, which

operates on DNA, RNAi works by silencing RNA, which is the immediate precursor of proteins implicated in the phenotype of interest.

Reagents consist principally of the interfering RNA construct and a transfection agent for introducing the RNA into cells. The most commonly used interfering RNAs are the short (19 to about 25 nucleotides) interfering RNAs (siRNAs) and short hairpin RNA (shRNA). Approximately 75 percent of the RNAi reagent market uses siRNA, according to Chris Cuning, Ph.D., senior manager of market development at Invitrogen (Carlsbad, CA). Both reagent types bind to complementary sequences on genes.

shRNA reagents are introduced in plasmid format, which means the target cells can incorporate the silencing agent into their genome and pass it on to offspring. “shRNA is absolutely needed when the phenotype takes longer than about two weeks to develop,” says Steven

Suchyta of Sigma-Aldrich (St. Louis, MO). shRNA may also be introduced into cells via a virus transfection agent. Some vendors offer lentivirus transfection re-

entry into RISC complexes. Furthermore, larger genes tend to be recognized by cells as viruses, which induces an undesirable interferon response.

**“The most commonly used interfering RNAs are the short (19 to about 25 nucleotides) interfering RNAs (siRNAs) and short hairpin RNA (shRNA).”**

agents that provide long-term, stable knockdown in almost any mammalian cell. Vendors also offer peptide-based reagents.

Reagent companies sell RNAi reagents as “virtual kits” consisting of the shRNA or siRNA sequences and an appropriate transfection reagent. Vendors usually guarantee that a certain percentage of multiple knockdown constructs they sell for a particular target RNA will succeed. Users can monitor the progress of their knockdown by performing a before-and-after Western blot to determine if the protein coded by the putative knockdown gene is still being produced.

Length is a critical attribute of siRNA and shRNA reagents. In nature, interfering RNA species are usually between 20 and 25 nucleotides in length. Longer constructs could theoretically work better since they cover a greater fraction of the target gene, but 20 to 25 nucleotide lengths are ideal for

RNAi may eventually have greater impact on biology than polymerase chain reaction (PCR), although RNAi can be considered more complex than PCR.

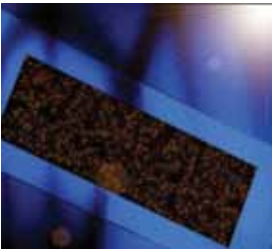
The main obstacle is introducing the interfering RNA sequence into the cell, into the location of the target gene, and then getting it to bind to and inactivate the target. Success with one sequence, transfection agent, and cell does not guarantee success when one variable changes.

Delivering interfering RNA into whole organisms (vs. cells) presents even greater challenges, but the potential rewards are also high. Whole-organism or whole-tissue knockdowns would provide new opportunities in drug testing and, eventually, for human therapy.

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Integrated DNA Technologies	<a href="http://www.idtdna.com">www.idtdna.com</a>
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