



Column Watch

This month's "Column Watch" is the first of a two-part series in which Ron Majors examines the trends in column introductions at Pittcon 2002. In part I, he describes high performance liquid chromatography (HPLC) columns and packings for reversed-, normal-, and bonded-phase; ion-exchange; ion; size-exclusion; and large- and preparative-scale chromatography. He also looks at specialty HPLC columns.

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New Chromatography Columns and Accessories at the 2002 Pittsburgh Conference, Part I

The 53rd Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy — Pittcon 2002 — returns to the Morial Convention Center in New Orleans, Louisiana, on 18–22 March 2002. With more than 1100 exhibiting companies and 1450 oral presentations, Pittcon remains the most important annual international analytical exhibition at which companies introduce their latest instruments, instrument accessories, columns, sample preparation products, and other consumable products. The purpose of this report is to provide information about many of the new separation consumables and accessory products that will be displayed at Pittcon 2002. In some cases, products that were introduced during 2001 but after Pittcon 2001 have been included for reasons of completeness. The information is based upon manufacturers' responses to a questionnaire mailed in December 2001. Because of space limitations and the fact that some manufacturers did not respond to the questionnaire, this report cannot be considered an exhaustive listing of all new products introduced in New Orleans this year. However, over the years, these Pittcon introduction summaries have been a good source of information that would be difficult to gather during the four days of the exhibition. In addition, the products introduced have shown definite correlations to current research, development, and application activity in the separation sciences.

As in previous years, columns and other products recommended by their manufacturers primarily for biomolecule separations are denoted in the tables with the designation *BIO*. Some of these products can be used for general-purpose high performance liquid chromatography (HPLC) separations as well, but their main applications are in bioseparations. I cite specific information

about bioapplications where appropriate. Manufacturers plan to introduce many products for biochromatography, drug discovery, and combinatorial chemistry this year; I discuss these products in the sections that best fit the manufacturers' intended applications.

In this month's column, I describe new introductions in the areas of high performance liquid, reversed-phase, normal- and bonded-phase, ion-exchange and ion, size-exclusion, large- and preparative-scale, and specialty chromatography columns. Next month, I will look at gas chromatography (GC) and supercritical fluid chromatography (SFC) columns, sample preparation products, and small hardware and accessories for chromatography and sample preparation.

Trends and Highlights

General: This year, the largest number of product introductions at Pittcon will be for biomolecule separations and for liquid chromatography–mass spectrometry (LC–MS), which currently are the hottest areas in chromatographic research and applications. Specialty HPLC columns for chiral, biomolecules, combinatorial chemistry, carbohydrate analysis, and LC–MS will represent the biggest category of entries. Also well represented will be capillary and nano-LC columns for limited sample mass situations, which require greater sensitivity, and for LC–MS and LC–MS–MS applications. More accessories for nano-LC, including valves, mixers, connecting tubing, and similar products, will be introduced. In sample preparation, more 96-well solid-phase extraction (SPE) and filtration plates, selective SPE phases, and polymeric phases will be exhibited.

HPLC columns: Reversed-phase HPLC maintains its dominance, and a significant number of reversed-phase columns with

Companies Listed in This Column

Advanced Chromatography Technologies,
Aberdeen, United Kingdom
Agilent Technologies Inc., Wilmington,
Delaware
Alltech Associates, Inc., Deerfield, Illinois
Amersham Biosciences, Piscataway, New
Jersey
Analytical Sales and Services, Inc.,
Pompton Plains, New Jersey
Ansys Technologies, Inc., Lake Forest,
California
BIA Separations d.o.o., Ljubljana, Slovenia
BioChrom Labs, Inc., Terre Haute, Indiana
Bischoff Chromatography, Leonberg,
Germany
Chiral Technologies Inc., Exton,
Pennsylvania
Cluzeau-Info-Labo, Sainte-Foy-La-Grande,
France
Daicel Chemical Industries Ltd., Osaka,
Japan
Dionex Corp., Sunnyvale, California
EKA Chemicals, Bohus, Sweden
Eprogen, Darien, Illinois
ES Industries, West Berlin, New Jersey
ESA, Inc., Chelmsford, Massachusetts
GL Sciences, Tokyo, Japan
Grace Vydac, Hesperia, California
Interchim, Montluçon, France
Jones Chromatography, Hengoed, United
Kingdom
Jordi Associates Inc., Bellingham,
Massachusetts
Macherey-Nagel GmbH & Co. KG, Düren,
Germany
Merck KGaA/EM Science, Darmstadt,
Germany
Mitsubishi Chemical America, Inc., White
Plains, New York
MODcol Corp., Sunnyvale, California
New Objective, Inc., Woburn,
Massachusetts
OraChrom, Woburn, Massachusetts
Phenomenex, Torrance, California
Polymer Laboratories, Amherst,
Massachusetts
Regis Technologies, Inc., Morton Grove,
Illinois
Showa Denko KK, Kanagawa, Japan
Supelco, Bellefonte, Pennsylvania
Thermo Hypersil-Keystone, Bellefonte,
Pennsylvania
Tosoh Biosep, Montgomeryville,
Pennsylvania
Upchurch Scientific, Oak Harbor,
Washington
Waters Corp., Milford, Massachusetts
YMC/Waters, Milford, Massachusetts
ZirChrom Separations, Inc., Anoka,
Minnesota

various types of embedded polar functional groups and phases for highly aqueous mobile-phase environments will be displayed. Monolithic columns will appear in both silica and polymeric chemistries; a validation kit also will debut. These columns potentially could lower the cost of a typical column. As far as I was able to determine, no irregularly shaped silica-gel-packed columns in analytical sizes will be introduced this year, so unless I state otherwise, assume that all the packings are spherical in nature. I have noted several series of preparative columns and bulk media for biomolecule separations.

Gas chromatography: Fewer GC columns will make debuts this year than in the past. Several of these columns will be extensions of existing product lines. The newest type of column is the sol gel column, which is prepared by a different synthetic method than regular coated or cross-linked stationary phases.

Sample preparation: Selective SPE phases are the name of the game this year with the most selective phases being the molecularly imprinted polymers. Phases that are selective for catecholamines, mixed phases for basic and acidic drugs, and a unique on-line protein digestion phase will be the highlights. The number of polymeric SPE phases almost equals that of silica-based ones this year.

Accessories: HPLC accessories will dominate the new accessory offerings this year, especially novel connecting tubing, fittings, connectors, a unique column nut for tight places, and nano-LC kits with products to convert liquid chromatographs or to better work with LC-MS systems. New fused-silica tubing and inert fused-silica inlet liners and some neat tools for working with GC inlets will debut. Molded polytetrafluoroethylene centrifuge tubes should provide an inert surface for biochemists to obtain better recovery of small amounts of analytes.

HPLC Columns and Packing Series

Each year manufacturers introduce entire new families of HPLC columns at Pittcon. For the sake of brevity, I have elected to cover those series here instead of listing each column under individual headings in the tables. Table I lists the new series of HPLC columns that will be displayed at Pittcon 2002. In some cases, the series are major extensions of existing products in the companies' offerings that cover an entire mode or group of phases; in other cases, the series are new to the market.

Micro- and nano-HPLC columns are among the most popular entries this year, which is true for the individual modes as well as for the new series. These columns usually are fused-silica capillaries or fused-silica-lined stainless steel capillaries that mimic the popular sizes of GC columns — 0.32 and 0.53 mm — and 0.70 mm, which is not a GC size; they are packed with 3- and 5- μm d_p HPLC packings. The advantage of these columns is their ability to interface with MS systems because they can operate at flow rates in the 5–50 $\mu\text{L}/\text{min}$ range, depending upon the column diameter. Capillary LC instruments or modifications of existing HPLC instruments often are necessary to use these small columns optimally. Hence, manufacturers also introduce hardware accessories (see “Chromatography and Sample Preparation Accessories” in next month’s issue) to ensure that dead volumes are minimized. Other advantages of these tiny inner diameter columns are their increased sensitivity in limited sample mass situations and their solvent savings because of the low flow-rate requirements.

The other area of significant column introductions is short, fast columns for high-throughput screening, combinatorial chemistry, and LC–MS. These columns have either 2.1- or 4.6-mm inner diameters and lengths of only 10–30 mm. Because of the small internal volumes, chromatographers must take care of their LC systems’ dead volumes to ensure that the column efficiency is maintained, especially if they are operated at high flow rates.

Reversed-Phase Chromatography Columns

As usual, many new reversed-phase columns will be introduced at Pittcon 2002 (see Table II). In fact, if I include the reversed-phase chromatography columns introduced under the series category, this year’s 37 new products or product lines indicate the continuing strong popularity of this technique. Most of the packings that will debut are silica-based. Only three polymer-based materials will be displayed, which indicates that even with their advantages of better stability, polymeric packings have not made major inroads into the reversed-phase market. Some silica monolith columns also will be introduced.

Because of the large number of reversed-phase materials, I have classified the phases according to their suggested chemistry or application emphasis based upon the manufacturer-provided information. Many

manufacturers classify their reversed-phase silica-based columns as base-deactivated, which means that the column has been treated so that it has minimal interaction and tailing with strongly basic compounds. Among the treatments are single- or

multiple-reactant endcapping. Type B silica (high purity, low trace-metal content, low acidity), and surfaces covered or encapsulated with polymeric phases. In reversed-phase chromatography, basic compounds frequently can interact with unreacted

silanols on the silica gel, because it is virtually impossible with monomeric bonding to remove or cover all of the silanols due to steric reasons. This interaction is most problematic when the packing is used at intermediate pH values (pH 4–8) at which

silanols and many basic compounds are partially ionized.

The largest single type of reversed-phase column this year is one recommended for analyzing polar and basic analytes and designated in Table II as polar-embedded

phases or high aqueous phases. This relatively new type of column is recommended for use in low organic solvent, highly aqueous environments, even with mobile phases consisting of 100% water. Most of these phases incorporate or embed a polar or

Table I: Series of high performance liquid chromatography columns at Pittcon 2002

Product Name	Supplier	Analytical	Preparative	Guard	Bulk	Modes	Phases	Comments
Ace LC/MS Performance cartridges	Advanced Chromatography Technologies	Yes	No	No	No	Reversed and normal phase	C4, C8, C18, high-load C18, cyano, phenyl, and aqueous	Ultrapurity silica (Type B) with 3-, 5-, 10-, and 15- μm particle sizes; columns are recommended for high-throughput screening applications; 1 and 3 cm \times 1.0–4.6 mm column dimensions; cartridges individually manufactured and tested; test chromatogram and other information provided; cartridge holder is reusable and has low-dead-volume direct connection; stainless steel construction.
Capcell Pak MF columns	ESA	Yes	No	Yes	No	Reversed phase and ion exchange	C1, C8, phenyl, and strong-cation exchange	50–150 mm \times 2.0 and 4.6 mm cartridge and conventional column hardware; stainless steel construction; packing material of polymer-encapsulated high-purity 80- \AA silica with chemically bonded phases; recommended for separating pharmaceuticals and other compounds in saliva, blood plasma, serum, and other biological fluids; columns permit direct injection of biological fluids without sample pretreatment using column-switching techniques.
Chiralcel H series columns	Daicel Chemical Industries	Yes	Yes	No	No	Chiral reversed phase, normal phase, and supercritical fluid	Chiral	Expanded line of H-series columns includes 5- μm d_p columns that provide increased column efficiency; include Chiralcel-OD-H, OJ-H, AD-H, and AS-H phases that cover 80% of typical chiral compounds; 150 and 250 mm \times 2.1, 4.6, 10, 20, and 30 mm column dimensions; Chiral Technologies represents Daicel Chemical Industries in the United States.
Discovery BIO wide-pore columns	Supelco	Yes	Yes	Yes	No	Reversed phase	C5, C8, and C18	Series of 300- \AA wide-pore, bonded-base, deactivated silica columns; 3-, 5-, and 10- μm d_p ; recommended for analyzing and purifying proteins and peptides; three different phase chemistries; 3.6, 5, and 9% carbon surface coverage for C5, C8, and C18 phases, respectively; analytical to preparative sizes available; 5, 10, 15, and 25 cm \times 2.1, 4.0, 10.0, and 21.2 mm column dimensions; matched selectivity across all particle sizes and column dimensions; <i>BIO</i> .
Discovery HS HPLC columns	Supelco	Yes	Yes	Yes	No	Reversed and normal phase	C18, pentafluorophenyl, and polyethylene glycol	C18 phase recommended for LC–MS applications; polyethylene glycol reversed-phase column has unique retention and selectivity and is recommended for analyzing phenolic compounds; pentafluorophenyl phase also has a unique selectivity and is recommended for analyzing basic and halogenated compounds; available in 3-, 5-, and 10- μm particle sizes.
Expedite LC–MS hardware	Alltech Associates	Yes	No	No	No	Reversed and normal phase	C18, phenyl, and silica	Short, fast columns for LC–MS and combinatorial chemistry; 10 and 20 mm \times 2.1 and 4.6 mm column dimensions; stainless steel construction; provide reduced analysis time, low solvent consumption, and enhanced sensitivity; series includes the company’s Prevail, Alltima, and Platinum phases.
Inertsil Micro columns	GL Sciences	Yes	No	No	No	Reversed and normal phase	C8, C18, polar endcapped C18, cyano, phenyl, and diol	Micro-LC column series; 150 and 250 mm \times 0.3, 0.5, and 0.7 mm column dimensions; guard columns available; ultrapurity silica base material with 3- and 5- μm average particle diameters and 100- \AA pore diameters.
Nano-Precolumn cartridges	Dionex	Yes	No	No	No	Reversed phase and cation exchange	Silica	Four functional groups: C4, C8, C18, and strong-cation exchange; C8 phase has 11% carbon phase coverage; C18 phase has 18% carbon phase coverage; 100- and 300- \AA pore sizes; 0.9-mL/g pore volume; 300 mm \times 1.0 mm microcartridge column with stainless steel hardware and 10-32 ferrule-style endfittings; recommended for two-dimensional (2-D) LC capillary separations of protein digests, preconcentration of diluted samples, desalting, and sodium dodecyl sulfate removal before MS detection; <i>BIO</i> .
Pioneer Direct Connection capillary columns	Thermo Hypersil-Keystone	Yes	No	No	No	Reversed and normal phase	Silica and others	Fused-silica direct-connection packed capillary columns available with many of the company’s phases; 30–150 mm \times 0.32 and 0.50 mm column dimensions; recommended for HPLC applications, especially LC–MS when the columns can serve as selective chemical interfaces with MS detectors.
Polyamide Bio Protein/Peptide columns	Jordi Associates	Yes	Yes	Yes	Yes	Reversed and normal phase, ion exchange, and size exclusion	Polydivinylbenzene base	Recommended for separating proteins and peptides by various modes; 4–5 μm d_p ; various pore sizes available; pH 1–14 range; can withstand temperatures as high as 140 $^{\circ}\text{C}$; <i>BIO</i> .
Purospher Star columns	Merck KGaA/EM Science	Yes	No	Yes	No	Reversed and normal phase	C8, endcapped C18, amino, and silica	Ultrapurity, 120- \AA pore diameter silica synthesized from tetra-alkyl silane; 3- and 5- μm d_p ; 30, 55, 75, 100, 125, 150, and 250 mm \times 1, 2, 3, 4, and 4.6 mm column dimensions; available in cartridges with integrated guard columns or Hibar column hardware; semipreparative columns available in 10-, 21.2-, and 25-mm i.d.; both reversed-phase packings are endcapped with cross-linking; pH 1.5–10.5 range; column phases include a balanced Tanaka test.
Shodex RSpak SS-50 columns	Showa Denko	Yes	No	No	No	Reversed and normal phase and ion exchange	Quaternary ammonium	Multimodal columns with polyvinyl alcohol base; 5- μm average particle diameters; 150 mm \times 2.0 and 4.6 mm column dimensions; recommended for separating acidic, neutral, and basic compounds; columns also can be used in ion-exclusion mode.

Table II: Reversed-phase chromatography columns at Pittcon 2002

Product Name	Supplier	Type	Base Material	Functional Group	Particle Diameters (μm)	Pore Sizes (\AA)	Comments
Acclaim 120 C18 reversed-phase column	Dionex	Regular	Silica	C18	3 and 5	120	High-purity, low-metal silica; monomerically bonded and endcapped; 18% carbon coverage ($3.2\text{-}\mu\text{mol}/\text{m}^2$); 0.9-mL/g pore volume; 300-m ² /g surface area; 50–250 mm \times 2.1–4.6 mm column dimensions; guard columns available; stainless steel construction.
Acclaim 120 C8 reversed-phase column	Dionex	Regular	Silica	C8	3 and 5	120	High-purity, low-metal silica; monomerically bonded and endcapped phase; 11.2% carbon coverage ($3.7\text{-}\mu\text{mol}/\text{m}^2$), 0.9-mL/g pore volume; 300-m ² /g surface area; 50–250 mm \times 2.1–4.6 mm column dimensions; guard columns available; stainless steel construction.
Ace C18-HL column	Advanced Chromatography Technologies	Base deactivated	Silica	C18	3, 5, 10, and 15	90	Ultra-high-purity Type B silica with 400-m ² /g surface area; 20% carbon coverage; base deactivated; wide range of configurations available, including cartridge, microbore, and preparative columns; high carbon loading provides increased retention relative to traditional C18 bonded phases; bulk packing available; stainless steel or polyetheretherketone (PEEK) hardware.
Alltima AQ column	Alltech Associates	Polar endcapped, high aqueous	Silica	C18	3 and 5	100	Hydrophilic endcapping allows the separation of polar molecules in a highly aqueous mobile phase; 33–250 mm \times 4.7–7.0 mm column dimensions; guard columns available; stainless steel construction.
Betasil Phenyl Hexyl column	Thermo Hypersil-Keystone	Regular	Silica	Phenyl-C6	3 and 5	100	High-purity Type B silica; 11% carbon coverage; mixed-mode phase offers unique selectivity for difficult separations of both polar and neutral compounds that might not be achieved on conventional C18 or other bonded reversed phases; cartridge columns available; capillary to analytical dimensions available; stainless steel construction.
Capcell Pak ACR column	ESA	Regular	Silica	C18	5	Unspecified	Ultra-high-purity silica; modified silicone polymer encapsulated; pH 1–10 range; especially recommended for use with acidic mobile phases and for LC-MS applications; 150 mm \times 4.6 mm column dimensions; stainless steel construction.
Capcell Pak MG column	ESA	Regular	Silica	C18	3 and 5	100	Ultra-high-purity silica; dense silicone polymer encapsulated; 5–18% carbon or 0.6–6.9 $\mu\text{mol}/\text{m}^2$ phase coverage; pH 2–10 range; recommended for separating polar basic compounds; 35–250 mm \times 1.5–20 mm column dimensions; cartridge configurations available; stainless steel construction.
Chromegabond WR-C18-EX column	ES Industries	High stability	Silica	C18	3, 5, 10, and 16	120	Recommended for separating basic compounds at high pH levels; 18% carbon coverage; pH 2–10 range; 1–30 cm \times 0.5–5.0 mm column dimensions; stainless steel and PEEK construction.
Chromolith Flash RP-18e column	Merck/EM Science	Regular	Silica	Endcapped C18	Not applicable	Macropores: 20,000; mesopores: 130	Chromolith C18e (endcapped) monolithic rod column with 18% carbon loading; 25 mm \times 4.6 mm column dimensions; recommended for high-speed separations at low back pressures; can tolerate flow rates as fast as 10 mL/min.
Chromolith Performance RP-18e validation kit	Merck/EM Science	Regular	Silica	Endcapped C18	Not applicable	Macropores: 20,000; mesopores: 130	A kit with three Chromolith C18e (endcapped) monolithic rod columns from three different batches for developing validated methods; 100 mm \times 4.6 mm column dimensions; 18% carbon loading; monolith design enables high flow rates with good efficiency.
Genesis AQ column	Jones Chromatography	High aqueous	Silica	C18–short alkyl	7	120	Recommended for separating polar compounds in highly aqueous mobile phases, even as much as 100%; 14% carbon coverage; 5–25 cm \times 4.6–100 mm column dimensions in analytical to process scale; guard columns available; stainless steel construction.
Inertsil Embedded Polar column	GL Sciences	Polar embedded, high aqueous	Silica	Unspecified	3 and 5	100	Recommended for water-soluble compounds at low percentages of organic mobile phases; can be used with 100% water as eluent; wide variety of dimensions, including preparative and guard columns.
Jupiter Proteo column	Phenomenex	Regular	Silica	C12	4 and 10	90	Ultra-high-purity Type B silica; 475-m ² /g surface area; proprietary endcapping; pH 1.5–10 stability; recommended for tryptic digests and small peptides; variety of column dimensions available; <i>BIO</i> .
Nucleodur 100 C18 EC column	Macherey-Nagel	Regular	Silica	C18	3 and 5	100	High-purity silica; recommended for analyzing polar compounds as well as general reversed-phase applications; 17.5% carbon coverage; 30–250 mm \times 1, 2, 3, 4, and 4.6 mm column dimensions; guard columns available; stainless steel construction.
Nucleodur C18 Gravity column	Macherey-Nagel	Base deactivated	Silica	C18	3 and 5	100	High-purity silica; 18% carbon coverage; reported pH 1–11 range; recommended for analyzing basic and other ionizable compounds such as pharmaceuticals; 30–250 mm \times 1, 2, 3, 4, and 4.6 mm column dimensions; guard columns available; stainless steel construction.
Polarity column	Waters	Regular	Silica	C18	3, 5, and 10	Proprietary	Recommended for retaining polar compounds in a wide range of applications such as drug discovery, method development, and nutraceutical analysis; peptides; compatible with 100% aqueous mobile phases; difunctional chemistry; low-pH stability; columns available from capillary to preparative sizes; cartridge columns and bulk packing available; stainless steel construction.
Prontosil HTS-Kit SH3 column	Bischoff Chromatography	Regular	Silica	C18	3 and 5	120	Two column kits — 30 mm \times 4.6 mm and 50 mm \times 4.6 mm — available; both columns are from same lot; 17% carbon coverage; recommended for combinatorial chemistry and high-throughput screening; other kits available; stainless steel construction.
Pursuit C18 column	Ansys Technologies	Base deactivated	Silica	C18	3, 5, 10, and 20	200	Ultra-high-purity Type B silica; recommended for the fast elution of lipophilic compounds with LC-MS and parallel preparative LC; pH 1–10 stability; multiple-batch method validation kits available; bulk packing available; 1–25 cm \times 1.0–50 mm column dimensions.
Pursuit Phenyl Hexyl column	Ansys Technologies	Base deactivated	Silica	Phenyl-C6	3, 5, 10, and 20	200	Ultra-high-purity Type B silica; unique selectivity provided by phenyl-hexyl chemistry; multiple-batch method validation kits available; recommended for pharmaceutical analysis; bulk packing available, variety of column dimensions; stainless steel hardware.
Source 5RPC ST 2.1/150 column	Amersham Biosciences	Polymer	PS–DVB*	PS–DVB	5	Unspecified	Recommended for separating peptides, nucleotides, and other small molecules and also for LC-MS; 150 mm \times 2.1 and 4.6 mm column dimensions; pH 1–12 range, can be cleaned to pH levels as high as pH 14; 0.9–1.5 mL/g pore; bulk packing available; stainless steel construction; <i>BIO</i> .
Stability RP 18 column	Cluzeau-Info-Labo	Base deactivated	Silica	C18	3 and 5	100	Ultra-high-purity silica; 15% phase coverage; recommended for analyzing endogenous compounds in human plasma such as HIV-protease inhibitors and nonnucleoside reverse transcriptase inhibitors; 250 mm \times 4.6 mm column dimensions; stainless steel construction; fused-silica capillaries also available.
Synergy Hydro-RP column	Phenomenex	Polar endcapped, high aqueous	Silica	C18	2, 4, and 10	80	Ultra-high-purity Type B silica; 475-m ² /g surface area; polar endcapping enables use in 100% aqueous mobile phase; pH 1.5–7.5 stability; recommended for retaining nonpolar and highly polar compounds and for LC-MS applications; column dimensions from capillary (0.3-mm i.d.) to preparative (100-mm i.d.); cartridge columns and bulk packing available.
Uptisphere HSC column	Interchim	Regular	Silica	C18	5	Proprietary	Ultra-high-purity Type B silica; 20% carbon coverage by monofunctional bonded and endcapping; pH 10 upper pH limit; 65 °C upper temperature limit; 20–300 mm \times 0.25–28 mm column dimensions; quick-seal system with direct guard column connection; cartridge columns available; stainless steel construction.
Uptisphere NEC column	Interchim	Regular	Silica	C18	5	120	Ultra-high-purity Type B silica; 16% carbon coverage by monofunctional bonded and no endcapping; 60 °C upper temperature limit; 20–300 mm \times 0.25–28 mm column dimensions; quick-seal system with direct guard column connection; cartridge columns available; stainless steel construction.
YMC-Pack Pro C18 RS column	YMC/Waters	High coverage	Silica	C18	5	80	Ultra-high-purity Type B silica with polymeric bonding, low trace-metal content, and endcapping; 22% carbon coverage; pH 1–10 range; recommended for analyzing various analytes; has strong retention for hydrophobic compounds.

*PS–DVB = poly(styrene–divinylbenzene).

nonionic functional group — amide, ether, urea, amine, or carbamate — into the alkyl-bonded-phase chain itself at some point in the bonding process.

Other manufacturers endcap the silica surface with a hydrophilic reagent, sometimes called a polar endcapping. The phase is primarily hydrophobic but with hydrophilic groups near the surface or in the alkyl chain that can be wetted with polar eluents. Thus, these phases can function well in a highly aqueous environment with little organic modifier present, as well as provide the typical reversed-phase behavior with water–organic solvent mixtures. Highly hydrophobic phases collapse when the organic solvent content becomes low (usually less than 5–10%, depending upon bonded-phase characteristics). The collapsed phase can yield variable retention, low solute recovery, and slow equilibration. Introducing the hydrophilic moiety into the alkyl chain imparts different selectivity and retention characteristics compared with more-hydrophobic reversed-phase materials. These phases work well with basic analytes because interactions with residual silanols are weakened when the embedded polar groups are present. Unlike the polar-embedded phases, some of the phases with polar endcapped silanols provide similar selectivity as regular hydrophobic phases but have lower retention.

Figure 1 shows an example of a separation of polar compounds using only a buffer (no organic modifier). The separation of these small organic acids sometimes

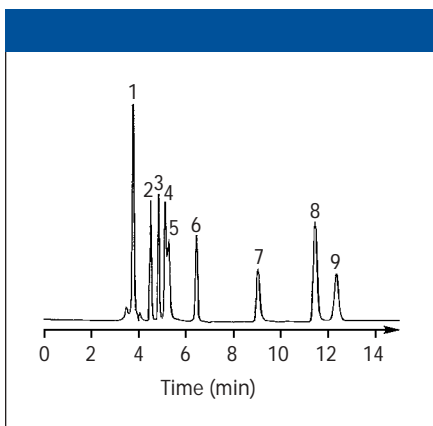


Figure 1: Separation of organic acids on a Synergi Hydro-RP column. Column: 250 mm × 4.6 mm, 4- μ m d_p Synergi Hydro-RP; mobile phase: 20 mM potassium phosphate (pH 2.9); flow rate: 0.7 mL/min; temperature: 22 °C; detection: UV at 220 nm. Peaks: 1 = oxalic acid, 2 = tartaric acid, 3 = glycolic acid, 4 = formic acid, 5 = pyruvic acid, 6 = malonic acid, 7 = acetic acid, 8 = maleic acid, 9 = citric acid. (Courtesy of Phenomenex.)

is difficult on more-hydrophobic phases because they tend to be eluted quite early.

Manufacturers have used other approaches to impart different selectivities from the regular C18 and C8 bonded reversed phases. At this year's Pittcon, mixed phases of two bonded-phase moieties will make their debuts. Mixed phases can offer a different selectivity compared with the separate bonded phases. For example, a mixed phenyl and hexyl phase would provide different retention than phenyl or hexyl phases alone.

Another trend I've noted is the advent of reversed-phase columns that can work within a wider pH range, especially on the basic side. Previously, most silica-based reversed-phase columns were limited to pH values of pH 8 or perhaps 9, depending upon the carbon coverage. Now, some manufacturers are claiming upper pH limits of pH 10 or even 11 with regular silica-gel bonded-phase columns. This move might be driven by recently introduced specialty and hybrid silica columns that use special chemistries to achieve high pH operation. High-pH operation is useful because basic compounds have an increased retention due to compounds with amine groups that no longer are ionized a couple of pH units above their pK_a . Polymer columns can work easily in the high pH region, but their efficiency is 65–75% lower than bonded silica gels with the same particle diameter. Bonded phases show decreased stability at high pH levels because of the attack of the underlying silica gel by hydroxide ion. The dissolution rate is affected by pH, ionic strength, counterion type, type of underlying silica, and the thickness and type of bonded functionality. For example, bonded silicas with long-chain functional groups (such as C18) are more resistant to dissolution than a short-chain bonded silica (such as C4).

Normal Bonded-Phase and Adsorption Chromatography Columns

Some of this year's normal-phase columns were already covered in Table I. Normal-phase chromatography still has its place in separation laboratories, especially for class separations and for analyzing water-sensitive samples, analytes that are insoluble in water, and certain geometric isomers that are difficult to separate by reversed-phase chromatography. The organic solvents used in normal-phase separations are more MS-friendly than some of the buffers typically used in HPLC. In reversed-phase

chromatography, HPLC operating conditions sometimes must be modified dramatically to allow compatibility with MS detection.

This year column manufacturers will show four new normal bonded-phase columns: two diols, an amino, and a fluorinated phase. The diol bonded-phase column is a polar column that is less polar and less acidic than a bare silica gel (carbinols versus silanols). Because diol phases generally include the $-\text{CH}_2\text{CH}(\text{OH})\text{CH}_2(\text{OH})$ functional group, the possibility exists that a column will display some reversed-phase characteristics. GL Sciences and Interchim will introduce diol phases.

The GL Sciences' Inertsil Diol column is available with 3- and 5- μ m d_p silica media and 100-Å pores or 300-Å pores (WP300 Diol column). For the 100-Å column, the diol phase coverage is 20% carbon. The recommended application for this column is the separation of sugars, because the diol shows unique selectivity for these compounds. The 300-Å version is recommended for analyzing larger molecules that might be sterically excluded from the 100-Å pores.

The Interchim Uptisphere Diol column is based on 6- μ m d_p ultrahigh-purity silica media with 120-Å pore diameters. Its unique features are its quick-seal column system that includes a direct guard-column connection and a 60 °C upper temperature limit. Both companies' diol columns are available in both analytical and preparative sizes.

The Phenomenex Luna Amino column is based on ultrahigh-purity 100-Å silica with 3-, 5-, or 10- μ m average particle sizes. This phase can be used for normal or reversed-phase chromatography, and it is particularly recommended for analyzing simple and complex sugars and sugar alcohols. When used with buffer solution in which the amino group is protonated, the column can serve as a weak anion exchanger. The phase is stable from pH 1.5 to pH 11, and it can be used with 100% aqueous mobile phases. Its phase coverage is 9.5% (equivalent to 5.8- $\mu\text{mol}/\text{m}^2$ coverage on a 400- m^2/g silica). Analytical, preparative and guard columns are available. Bulk packing also can be purchased by chromatographers who prefer to pack their own columns.

The most unusual normal bonded phase to be introduced will be the Chromega-bond NP-FluoroSep column from ES Industries. The phase has a naphthyl fluoro

functionality and shows a remarkably different selectivity compared with normal phases such as silica, cyano, and diol phases. This difference undoubtedly is due to the possible π - π interactions of the functional group. A wide variety of column dimensions, including guard and cartridge columns, is available in stainless steel or polyetheretherketone (PEEK) column hardware.

Ion-Exchange and Ion Chromatography Columns

As Table III lists, manufacturers will display eight new ion-exchange and ion chromatography columns — five cation- and three anion-exchange columns — at Pittcon 2002. Continuing with the trend of the past few years, polymer-based columns represent the majority of these introductions; only one silica-based product will debut. Polymeric columns have a wider pH operating range, and they can be used and cleaned with harsh reagents such as sodium hydroxide, which are favored by

biochemists to remove residual proteins. Both PEEK and stainless steel column hardware are used. For ion chromatography applications, PEEK hardware seems to be preferred because any potential cations that might be leached from the stainless steel are absent. Most of this year's ion-exchange columns are recommended for separating biomolecules, which is the hot application area for Pittcon 2002.

Ion chromatography is used for separating trace inorganic and low molecular weight organic anions and cations using suppressed-conductivity detection and isocratic elution. Manufacturers will introduce columns for analyzing low molecular weight alkyl amines and inorganic cations at sub-part-per-billion levels and for oxyhalides in drinking water, which is an important environmental application.

An interesting column in the ion-exchange area is Dionex's IonPac Cryptand A1 column, which has an adjustable exchange capacity controlled by changing the counterion in the mobile phase. The

cryptand bicyclic cage structure (Figure 2a) is similar to crown ethers but can have a much stronger binding constant. At high-pH eluent conditions, the cryptand structure by itself has little ion-exchange property. However, in the presence of metal cations, a positively charged site is generated with an associated counterion, which allows anion exchange to occur as in conventional ion-exchange chromatography. If the metal cation has a low binding constant, such as lithium, which has a binding constant of approximately 1, very few ion-exchange sites are generated and users observe a very low capacity. However, if a cation with a high binding constant such as sodium with a binding constant of approximately 3.9 is used, analysts will observe an intermediate capacity for anion chromatography. Although many metal cations can be used for complexation, sodium hydroxide and lithium hydroxide can be used successfully for most applications. On rare occasions, when a high-capacity mode is required, analysts can use

potassium hydroxide with a binding constant of approximately 5.4 for separating early eluted organic acids such as quinate, glycolate, acetate, and formate. Figure 2 shows the separation of seven common anions. In Figure 2b, an isocratic separation was achieved using 23 mM sodium hydroxide as the eluent. In Figure 2c, the same anions were separated using a capacity gradient that started with an initial eluent of 10 mM sodium hydroxide with a step change to 10 mM lithium hydroxide at 0.1 min. The separation of Figure 2c provided a shorter run time and improved peak efficiency. Capacity gradients, which can be used to control selectivity and run time, can be used for cryptand columns rather than eluent concentration gradients, which typically are used with anion-exchange columns.

Size-Exclusion Chromatography Columns

Companies submitted three new size-exclusion columns to LCGC for Pittcon

introduction, two for nonaqueous size-exclusion chromatography (also known as gel-permeation chromatography) and one for aqueous size-exclusion chromatography (sometimes called gel-filtration chromatography). The lone aqueous-compatible column was Thermo Hypersil-Keystone's BioBasic SEC silica-based column, which is derivatized by covalently bonding a hydrophilic polymer. The 5- μm d_p media have 60-, 120-, 300-, and 1000-Å pore sizes to cover proteins, peptides, and other biomacromolecules ranging in size from 100 Da to approximately 4×10^6 Da. Analytical, preparative, fused-silica capillary, and guard columns packed with the BioBasic SEC phase are available.

Gel-permeation chromatography columns will be displayed by BioChrom Labs and Showa Denko. The BioChrom column, called the Hydrocell GPC 3000 HS, is a poly(styrene-divinylbenzene) (PS-DVB) column with a 7-13 μm particle-size range. It is available in 150 mm \times 7.8 mm and 300 mm \times 7.8 mm

packed columns. With a high pore volume, the column can be used for high-speed analysis and purification of high molecular weight synthetic polymers. The phase also is available as a bulk packing.

The second gel-permeation chromatography column will be introduced by Showa Denko and actually is a series of columns. The Shodex GPC LF series is based on PS-DVB columns packed with 8- μm d_p media. The series has three columns: LF-404, LF-604, and LF-804. The 250 mm \times 4.6 mm LF-404 column is recommended for high-resolution separations.

Table III: Ion-exchange and ion chromatography columns at Pittcon 2002

Product Name	Supplier	Type	Base Material	Functional Group	Particle Diameters (μm)	Pore Size (Å)	Comments
BioAssist S column	Tosoh Biosep	Cation	Polymethyl methacrylate	Sulfopropyl	7	1300	Recommended for separating proteins and peptides; 50 mm \times 4.6 mm column dimensions; sample capacity as great as 100 $\mu\text{g}/\text{mL}$; PEEK construction; <i>BIO</i> .
BioBasic SCX column	Thermo Hypersil-Keystone	Cation	Silica	Sulfonic acid	5	300	High-purity silica derivatized with hydrophilic polymer; ion-exchange capacity: 0.07 mequiv/g; recommended for LC-MS analyses and ion-exchange separations of proteins, peptides (fractionation in tryptic digests), and small pharmaceutical molecules; various dimensions available, including preparative, fused-silica packed capillary, and cartridge columns; <i>BIO</i> .
IonPac Cryptand A1 anion-exchange column	Dionex	Anion	PS-DVB	Cryptand	5	100	Cryptand is a bicyclic cage compound that can complex metal cations such as sodium, lithium, or potassium; column has adjustable exchange capacity controlled by changing the cation counterion in the mobile phase; recommended for separating mono- and polyvalent anions in a single run and for determining trace anions in concentrated acids; guard columns available; PEEK construction.
IonPac CS12A-MS cation-exchange column	Dionex	Cation	See Comments	Carboxylic and phosphonic acids	8	100	Polymer base is ethylvinylbenzene 55% cross-linked with divinylbenzene; functional groups are surface-grafted; recommended for separating low molecular weight alkyl amines, ammonium, and inorganic cations with conductivity or electrospray ionization MS detection; can measure alkyl amines to sub-part-per-billion levels; 100 mm \times 2 mm column dimensions; column compatible with electrolytic suppressor for removing salt counterions before detection; PEEK construction.
Shodex IC SI-52 4E column	Showa Denko	Anion	Polyvinyl alcohol	Quaternary ammonium	5	Unspecified	Recommended for analyzing oxyhalides with suppressor methods; can be applied to U.S. Environmental Protection Agency Method 800.1; water dip and carbonate system peak do not overlap with common anions; can measure chlorite and bromate ions at levels as low as 5 $\mu\text{g}/\text{L}$ without influence from chloride and bromide ions; PEEK construction.
Styros CM column	OraChrom	Cation	PS-DVB-methacrylate	Carboxymethyl	5-25	Gigaporous	Recommended for separating biomolecules at most pH values and at high flow rates; larger columns can be used as cartridges in simulated moving bed chromatography; packing can be cleaned in place with harsh reagents such as sodium hydroxide; 3.3-250 mm \times 0.5-20 mm column dimensions; stainless steel and PEEK construction; <i>BIO</i> .
Styros SE column	OraChrom	Cation	PS-DVB-methacrylate	Sulfoethyl	5-25	Gigaporous	Recommended for separating biomolecules at most pH levels and at high flow rates; larger columns can be used as cartridges in simulated moving bed chromatography; can be cleaned with harsh reagents such as sodium hydroxide; 3.3-250 mm \times 0.5-20 mm column dimensions; stainless steel and PEEK construction; <i>BIO</i> .
TSKgel BioAssist Q column	Tosoh Biosep	Anion	Polymethyl methacrylate	Polyamino	10	4000	Recommended for separating proteins, peptides, and nucleic acids; large pores enable separation of antibodies and larger proteins; 50 mm \times 4.6 mm column dimensions; PEEK construction; <i>BIO</i> .

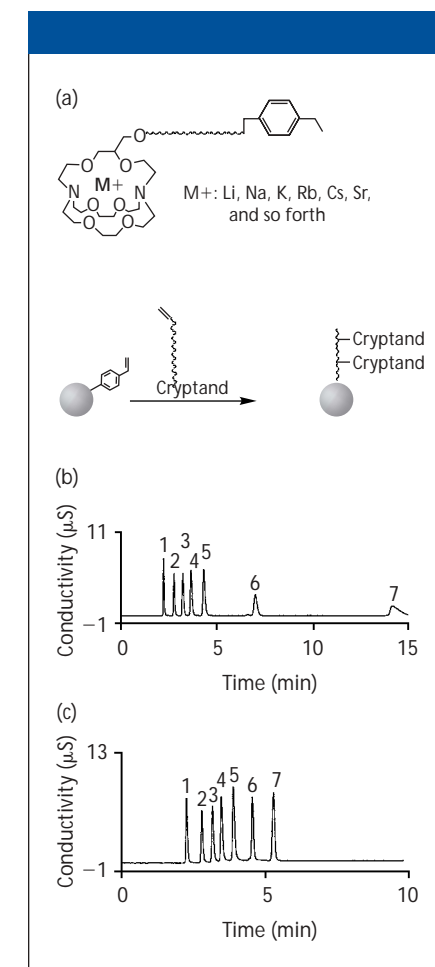


Figure 2: The cryptand column. Shown are (a) the structure of the 2,2,2 cryptand monomer and its attachment to column packing, (b) an isocratic separation of common anions, and (c) a capacity gradient separation of common ions. Column: IonPac Cryptand A1; mobile phase: (b) 10 mM sodium hydroxide, (c) 10 mM sodium hydroxide with a step at 0.1 min to 10 mM lithium hydroxide; flow rate: 0.5 mL/min; injection volume: 5 μL ; temperature: 35 $^{\circ}\text{C}$; detection: suppressed conductivity, ASRS-Ultra 2-mm, external water mode with ATC (35 mm \times 4 mm). Peaks: 1 = fluoride (2 mg/L), 2 = chloride (3 mg/L), 3 = nitrite (5 mg/L), 4 = bromide (10 mg/L), 5 = nitrate (10 mg/L), 6 = sulfate (5 mg/L), 7 = phosphate (15 mg/L). (Courtesy of Dionex Corp.)

The 150 mm × 6.0 mm LF-604 column is intended for rapid analysis. Finally, the LF-804 column is designed to have a wide linear range in its molecular weight calibration curve and has improved lower molecular weight linearity.

Large- and Preparative-Scale Chromatography Columns

The definition of preparative chromatography always has been fuzzy; it is in the eyes of the beholder, because the mass of the injected or collected sample often is dependent upon the amount available. For some, a few micrograms of material is sufficient for additional characterization or use, but for others, a few grams represents a preparative amount. As Table IV indicates, this year at Pittcon companies will present a larger number of semipreparative or preparative columns and bulk packings compared with last year. Column inner diameters will range from 10 mm to 30 mm.

Five packings will be silica based, and three polymeric-based phases will use PS-DVB and polymethacrylate. One

advantage of polymer-based columns in preparative work is that they can be cleaned with harsh reagents frequently, because most preparative columns are expensive and must be used for many injections. Some introductions include a matched set of analytical and preparative columns for linear scaleup. Another introduction will be a set of two columns with matched chemistries. Several of the columns are for biomolecules, and some are for combinatorial chemistry purifications.

Specialty HPLC Columns

Specialty columns are HPLC columns that have been developed for specific separations that are difficult to achieve on a standard column. Sometimes manufacturers will use a standard column, test it specifically for a certain class of compounds, and provide a recommended set of chromatographic conditions. In some cases, specialty columns come as part of a total-solution kit that includes reagents, standards, and method. Most specialty columns come with a test chromatogram from an analysis

performed at the factory before shipment, and some are guaranteed. Table V shows the 31 specialty columns that will be presented at Pittcon 2002. Silica gel-based columns outnumber polymer-based columns two to one.

The largest category of specialty columns comprises those designated for separating biomolecules, mainly proteins, peptides, and DNA fragments. Approximately one-half of the specialty columns are in this category. Several of these biochromatography columns are designed to be directly interfaced with MS detectors.

I included capillary columns specifically designed for LC-MS in the specialty columns category. Capillary columns have major advantages for analyzing small samples encountered in peptide digests because they can provide good sensitivity in limited-sample situations and can be interfaced directly with an MS source. Capillary columns with high-pH bonded silica gel allow the use of ammonium hydroxide as an MS-friendly buffer system. Two-dimensional (2-D) capillary chromatography coupled with MS could become an

important replacement technique for 2-D gel electrophoresis. After the methodology proves to be rugged and reproducible, first fractionating a peptide digest on a cation-exchange capillary with subsequent desalting and transferring of the fractions to a reversed-phase capillary and then to an MS system could be a preferred technique.

OraChrom will introduce a unique set of polymeric columns used for metal-chelate affinity chromatographic separation of proteins. By loading metal atoms, in this case copper(II) ion, onto the complexing chelating groups of the two columns, the column exhibits different selectivities under the same chromatographic conditions, as Figure 3 shows.

Short LC-MS columns are another popular area for introductions. Typically, these columns have 3–20 mm lengths and 1.0–2.1 mm inner diameters. These columns' small volumes require optimized system dead volumes. Their peaks are very narrow — typically 10–1000 μ L wide — and they often are used in the single-ion monitoring mode because more time is required to acquire data in the scan mode.

Other important application areas for specialty columns are enantiomeric compound, sugar and polysaccharide, organic acid, and environmental sample analysis. The most popular 10- μ m d_p chiral columns have been modified to 5- μ m d_p media, which should help when separating closely eluted enantiomers because of their higher efficiency.

Figure 4 illustrates how a specialty column for separating carbohydrate mixtures was used to separate various saccharides and sugar alcohols. Using an evaporative light-scattering detector enabled the use of a water-acetonitrile gradient to elute the larger oligomers.

Monolith columns also are among the specialty columns to be introduced. Both silica- and polymer-based monoliths will be displayed at Pittcon 2002, but only the polymer-based columns are suitable for macromolecule separations in the affinity and ion-exchange chromatography modes.

Acknowledgment

I would like to thank the manufacturers and distributors that kindly furnished the

Table IV: Preparative- and process-scale chromatography columns at Pittcon 2002

Product Name	Supplier	Modes	Base Material	Functional Groups	Particle Diameter (μ m)	Dimensions	Comments
Ace Prep columns	Advanced Chromatography Technologies	Reversed and normal phase	Silica	C4, C8, C18, high-loaded C18, cyano, phenyl, and aqueous	5, 10, and 15	5–25 cm × 21.2, 30, and 50 mm	Family of preparative columns packed in stainless steel hardware; based on ultrahigh-purity, base-deactivated silica; recommended for preparative and combinatorial chemistry; column kits of matched analytical and preparative packings available for scale-up purposes.
Chiralcel OD-H columns	Daicel Chemical Industries	Chiral	Silica	Cellulose tris(3,5-dimethylphenyl carbamate)	5	250 mm × 10, 20, and 30 mm	Columns can be used for preparative LC or SFC; the smaller particle size provides increased resolution compared with earlier 10- μ m d_p materials.
Custom-Packed columns	MODcol	Reversed and normal phase	Silica	C4, C8, and C18	5	5–25 cm × 20 mm	Columns packed with EKA Chemicals' Kromasil media; 100-Å silica pore size; new hardware design; stainless steel construction.
MCI Gel CHP2MGY media	Mitsubishi Chemical America	Reversed phase	Methacrylate	Methacrylate	30	Not applicable	Bulk packing; 400–600 Å wide-pore diameter; intermediate polarity surface with less tailing than classic styrenic or bonded silicas; wide pH capability; recommended for analyzing small molecules such as peptides, protein fragments, and oligonucleotides; <i>BIO</i> .
MCI Styrenic gels	Mitsubishi Chemical America	Reversed phase	PS-DVB	PS-DVB	15, and 30	Not applicable	Available only as bulk packing; a family of styrenic adsorbent resins designated as the CHP series; 20A has 15- μ m particles and 20Y has 30- μ m particles; 200- and 500-Å pore diameters; recommended for analyzing peptides, protein fragments, and oligonucleotides; wide pH range; can be cleaned with harsh reagents such as sodium hydroxide; <i>BIO</i> .
Polymeric media	Polymer Laboratories	Reversed phase	PS-DVB	PS-DVB	10, 10–15, and 15–20	Not applicable	Bulk packing recommended for process chromatographic purification of biopharmaceuticals from microgram to multikilogram scale; 100- and 300-Å average pore diameters; wide pH range; can use harsh solvents such as 1 M sodium hydroxide for cleaning; 200 kg/600 L single batch lot size for packing dynamic axial columns as large as 1-m i.d.; trial columns and small bottles of bulk packing available; <i>BIO</i> .
ProntoSIL HTS-Kit SH10P	Bischoff Chromatography	Reversed phase	Silica	C18	5 and 10	50 mm × 20 mm and 100 mm × 16 mm	Column kit with two columns that have matched chemistries from the same lot; silica has 120-Å average pore diameter; 17% carbon loading; recommended for combinatorial chemistry and high-throughput screening; stainless steel construction.
25-mm Spring column	MODcol	Reversed phase and chiral	Silica	C4, C8, C18, and chiral	5, 7, 10, 15, and 20	5–35 cm × 25 mm	Self-packing stainless steel column hardware system; recommended for combinatorial chemistry and peptide purification applications.
ZirChrom Prep columns	ZirChrom Separations	Reversed phase and ion exchange	Zirconia	Various	5, 7, 10, and 20	Various	Company provides semipreparative and preparative formats for all of its zirconia-based materials with pH 1–14 stability from and 200 °C upper temperature limits.

Table V: High performance liquid chromatography specialty columns at Pittcon 2002

Product Name	Supplier	Type	Applications	Base Material	Functional Groups	Particle Diameters (μm)	Pore Sizes (Å)	Comments
BioBasic C18 column	Thermo Hypersil-Keystone	Reversed-phase column	Biopurifications	Silica	C18	10	300	High-purity, base-deactivated silica; 9% carbon coverage; recommended for purifying proteins, peptides, polynucleotides, and other biomolecules, including small molecules; analytical- to preparative-scale (as large as 21.4-mm i.d.) columns available; guard columns available; <i>BIO</i> .
Capillary Sample Trap column	Upchurch Scientific	Trapping column for micro-LC	Concentrating and desalting for LC-MS	Silica	C18	5	300	Packed capillary recommended for use in microflow applications; trap concentrates dilute samples to improve sensitivity and desalting of sample matrix for improved interfacing with MS systems; 2.5 cm × 50 μm column dimensions; fused-silica tubing in PEEK housing with integrated microfiltration screen.
Ceramospher Chiral column	ESA	Chiral column	Enantiomeric compound analysis	Ceramic	Ruthenium complex	5	40	Stationary phase is a sodium magnesium silicate particle with a 300-m ² /g surface area; applicable to a wide range of chiral compounds; can tolerate aqueous to organic mobile phases; 250 mm × 4.6 mm column dimensions; stainless steel construction.
Chiralpak AD-H and AD-RH columns	Daicel Chemical Industries	Chiral column	Enantiomeric compound analysis	Silica	Amylose tris(3,5-dimethylphenyl carbamate)	5	Unspecified	Recommended for use with normal-phase solvents; 150 and 250 mm × 2.1, 4.6, and 10 mm column dimensions for analytical- and preparative-scale applications; columns also can be used in SFC separations; 5-μm d _p media provide higher efficiency than more-common 10-μm d _p chiral columns; AD-RH (2.1-mm i.d.) version is recommended for LC-MS applications; columns sold in the United States by Chiral Technologies.
Chiralpak AS-H column	Daicel Chemical Industries	Chiral column	Enantiomeric compound analysis	Silica	Amylose tris [(S)-α-methylbenzyl carbamate]	5	Unspecified	Recommended for use with normal-phase solvents; 150 and 250 mm × 4.6, 10, 20, and 30 mm column dimensions for analytical- and preparative-scale applications; large-inner-diameter columns also can be used in SFC separations; 5-μm d _p media provide higher efficiency than more-common 10-μm d _p chiral columns; columns sold in the United States by Chiral Technologies.
Chromegabond CTI column	ES Industries	Charge transfer column	LC-MS	Silica	Proprietary	3, 5, 10, and 16	120	Recommended for use in LC-MS with high levels of organic solvent in the mobile phase; phase provides enhanced selectivity with highly organic mobile phases relative to traditional C18 phases; 1-30 cm × 0.5-50 mm column dimensions; stainless steel or PEEK construction.
Chromegabond DNA column	ES Industries	Biomolecule separation column	DNA fragment analysis	PS-DVB	Alkyl chain	3 and 5	500	Recommended for analyzing DNA fragments with one base pair resolution to 250 base pairs; 3-15 cm × 0.5-4.6 mm column dimensions; cartridge column available; stainless steel and PEEK construction; <i>BIO</i> .
Chromegabond Primer-Pure column	ES Industries	Biomolecule separation column	DNA primer analysis	Silica	Alkyl chain-mixed C4, C8, and C18	3, 5, and 10	300	Recommended for separating single- and double-strand DNA primers from 20-50 base pairs with unit base pair resolution; 1-30 cm × 0.5-5.0 mm column dimensions; cartridge columns available; stainless steel and PEEK construction; <i>BIO</i> .
CIM Protein A-8 HLD tube column	BIA Separations	Immunoaffinity monolith	Mono- and polyclonal antibody purification	Polymer (see Comments)	Protein A	Unspecified	Macropores: 15,000; mesopores: 1000	HLD = high ligand density; Protein A CIM 8-mL tube monolith column recommended for purifying antibodies in high-productivity and high-throughput situations; monolith polymer is poly(glycidylmethacrylate-co-ethylene glycol dimethacrylate); cartridge columns available; 45-mm × 1.5 mm column dimensions; 15-mm active bed outer diameter; 8-mL volume; 12-15 mg IgG/mL dynamic binding capacity; polyacetal or stainless steel construction; <i>BIO</i> .
CIM Protein G disk	BIA Separations	Immunoaffinity monolith	Mono- and polyclonal antibody purification	Polymer (see Comments)	Protein G	Unspecified	Macropores: 15,000; mesopores: 1000	Applications, structure, and properties of this monolith polymer are similar to the company's CIM Protein A-8 HLD, but the disk has a Protein G immunoaffinity phase; disk format with a 16-mm i.d. with a 0.34-mL volume; cartridge constructed of polyacetal, polypropylene, and stainless steel; rigid monolithic column has low back pressure, flow-independent resolution, and flow-independent binding capacity; <i>BIO</i> .
CIM QA-80 tube column	BIA Separations	Anion-exchange monolith	Biomacromolecule analysis	Polymer (see Comments)	Quaternary amine	Unspecified	Macropores: 15,000; mesopores: 1000	Tube monolithic anion-exchange column recommended for fast preparative separations of proteins, peptides, and nucleotides; monolith polymer is poly(glycidylmethacrylate-co-ethylene glycol dimethacrylate); cartridge columns available; 85 mm × 3.0 mm column dimensions; 35-mm active bed outer diameter; 80-mL volume; polyacetal or stainless steel construction; <i>BIO</i> .
DACH-DNB chiral column	Regis Technologies	Chiral column	Enantiomeric separation analysis	Silica	1,2-Diaminocyclohexane	5 and 16	Unspecified	Pirkle-type chiral stationary phase; 100-Å pore diameter; recommended for analyzing a wide variety of racemates, including amides, alcohols, esters, ketones, acids, sulfoxides, phosphine oxides, selenoxides, phosphonates, β-lactams, and various heterocyclics; bulk packing available; 250 mm × 4.6 mm column dimensions; stainless steel construction.
Hydrocell RP 20F columns	BioChrom Labs	Polymer columns	Biomacromolecule analysis	PS-DVB	PS-DVB	14-25	Unspecified	Columns recommended for separating proteins, polynucleotides, and oligonucleotides; pH 1-14 range; 5-25 cm × 2.1-21.2 cm column dimensions; stainless steel construction; <i>BIO</i> .
LC-MS capillary columns	Grace Vydac	LC-MS columns	Protein analysis	Silica	C18	5	300	Recommended for analyzing small sample volumes in high-throughput separations for LC-MS in pharmaceutical and biotechnology laboratories; high-purity base silica; columns can be used with reduced levels of trifluoroacetic acid: 50, 100, 150, and 250 mm × 75, 150, 300, and 500 μm column dimensions; stainless steel and fused-silica construction; <i>BIO</i> .
PicoFrit columns	New Objective	Biomolecule separation column	Protein analysis and LC-MS	Silica	Reversed phase and strong-cation exchange	5	300	Capillary columns constructed with fused-silica tubing; 75-μm i.d. with integral tip for electrospray MS; mixed phases available; recommended for rapid analysis of complex protein mixtures without 2-D separations; <i>BIO</i> .
Polaris C18-B columns	Ansys Technologies	Polar-modified reversed-phase columns	Polar compound analysis	Silica	Polar-modified C18	3, 5, 10, and 20	Unspecified	Columns recommended for fast-gradient and LC-MS applications, especially drug discovery and parallel preparative LC; high-purity base silica; pH 1-10 stability; 1-25 cm × 1.0-50 mm column dimensions; multiple-batch validation kits available; bulk packing available.
Prevail Carbohydrate ES column	Alltech Associates	Polymer column	Carbohydrate separations	Hydrophilic polymer	Amine	5	300	Recommended for separating sugars such as simple sugars, oligosaccharides, and polysaccharides from a variety of complex mixtures; pH 1-13 range; 7.5, 53, 100, 150, and 250 mm × 4.6 and 7 mm column dimensions; stainless steel construction.
Prevail Organic Acid column	Alltech Associates	Reversed-phase column	Organic acid analysis	Silica	Proprietary	3 and 5	110	Recommended for separating short-chain organic acids using acidic mobile phases; column is tested with organic acid test mixture; can operate in 100% aqueous mobile phase; 7.5-250 mm × 4.6 and 7 mm column dimensions; stainless steel construction.
ProntoSIL HTS Kit BIO200AQ3	Bischoff Chromatography	Analytical column kit	Combinatorial chemistry and high-throughput screening	Silica	C18	3 and 5	200	Analytical column kit for analyzing large biomolecules; choice of two dimensions: 50 mm × 4.6 mm or 30 mm × 4.6 mm; 9% carbon phase coverage; ultrahigh-purity silica base material; wettable in 100% aqueous mobile phases without phase collapse; columns are taken from same lot; columns are useful for desalting, concentrating, and separating biomolecules; <i>BIO</i> .
ProntoSIL HTS Kit BIO300EPS5P	Bischoff Chromatography	Preparative column kit	Combinatorial chemistry and high-throughput screening	Silica	C18	5 and 10	200 and 300	Preparative-scale column kit for analyzing large biomolecules; choice of two dimensions: 50 mm × 20 mm or 100 mm × 16 mm; polar-embedded stationary phase; 8.5% carbon phase coverage; columns are taken from same lot; stainless steel column construction; <i>BIO</i> .
ProntoSIL HTS Kit BIO330H3	Bischoff Chromatography	Analytical column kit	Combinatorial chemistry and high-throughput screening	Silica	C18	3 and 5	300	Analytical column kit for analyzing large biomolecules; choice of two dimensions: 50 mm × 4.6 mm or 30 mm × 4.6 mm; 7% carbon phase coverage; ultrahigh-purity silica base material; columns are taken from same lot; <i>BIO</i> .
ProteoSep kit	Eprogen	Biomolecule separation kit	Protein analysis	Proprietary and silica	Unspecified	Unspecified	Proprietary	Column kit has two columns and associated buffers; one column is for chromatofocusing and the other is a nonporous-silica reversed-phase column; recommended for separating intact proteins from whole-cell lysates to map complex protein mixtures; an alternative to 2-D gels; 250 mm × 2.1 mm column dimensions; stainless steel construction; company formerly called Eichrom Technologies; <i>BIO</i> .
Shodex Mspak GF-4A column	Showa Denko	Polymeric column	Removing surfactants from biofluid samples	Polyvinyl alcohol	Polyvinyl alcohol	5	Unspecified	Porous polymer column that works in reversed- and normal-phase and size-exclusion chromatography modes; recommended for analyzing proteins without the influence of surfactants using column switching; 10 mm × 4.6 mm column dimensions.
Short Fast columns	Grace Vydac	Fast LC columns	Protein purifications	Silica	C18	5 and 10	300	Recommended for high-throughput separations and protein purifications; high-purity base silica; 50 and 100 mm × 2.1, 4.6, 10, 22, and 50 mm column dimensions; stainless steel construction; <i>BIO</i> .
Sprite column	Analytical Sales and Service	LC-MS column	LC-MS	Silica	C18	Unspecified	Unspecified	A small direct-connect column constructed of PEEK for ballistic gradient use in LC-MS; 20 mm × 2.1 mm column dimensions; recommended for high-throughput assays.
Styros LC-MS column	OraChrom	LC-MS column	Multidimensional protein identification	PS-DVB-methacrylate	PS-DVB-methacrylate	5	Gigaporous	For microbore and capillary fast analysis LC-MS and multidimensional protein identification technology; after on-line digestion, the resulting peptides are loaded onto 2-D capillary columns (ion-exchange in tandem with reversed-phase) and then electrosprayed to MS; columns have a wide pH range and require no trifluoroacetic acid; <i>BIO</i> .
Styros MC-IDA column	OraChrom	Metal chelate affinity column	Protein analysis	PS-DVB-methacrylate	Iminodiacetic acid	5-25	Gigaporous	Polymeric packing material is a three-dentate metal-chelate medium; has a wide pH range and can be cleaned with harsh reagents such as sodium hydroxide; stronger adsorbent than the company's MC-TED version; 3.3-250 mm × 0.5-20 mm column dimensions; stainless steel and PEEK construction; <i>BIO</i> .
Styros MC-TED column	OraChrom	Metal chelate affinity column	Protein analysis	PS-DVB-methacrylate	Tris(carboxymethyl) ethylenediamine	5-25	Gigaporous	Polymeric packing material is a five-dentate metal-chelate medium; has wide pH range and can be cleaned with harsh reagents such as sodium hydroxide; a weaker sorbent than the company's MC-IDA version; suggested applications include purification of human γ-interferon and proteins with surface histidine, cysteine, or tryptophan and separations requiring high salt to dissociate and separate binding proteins to lactoferrin from human milk or granulocytes; 3.3-250 mm × 0.5-20 mm column dimensions; stainless steel and PEEK construction; <i>BIO</i> .
Sucrobead I column	ESA	Carbohydrate column	Carbohydrate and simple sugar analysis	PS-DVB	Quaternary alkyl ammonium	7	Unspecified	Recommended for separating sugars with amperometric electrochemical detection using gold electrodes; provides baseline separations of mono- and disaccharides; 35, 150, and 250 mm × 2 mm column dimensions; stainless steel construction.
WP 300 C18 column	GL Sciences	Reversed-phase column	Peptide separations	Silica	C18	3 and 5	300	Available in various column dimensions for analytical- and preparative-scale work; guard columns available; <i>BIO</i> .
Zorbax capillary columns	Agilent Technologies	Biomolecule separation columns	Protein and peptide analysis, tryptic digests, and LC-MS	Silica	C18	3.5	300	Capillary columns for high-sensitivity analyses, especially in limited sample mass situations; Zorbax StableBond 300C18 phase recommended for low-pH separation of biomolecules; Zorbax Extend C18 phase recommended for applications with pH levels as high as pH 11, especially with ammonium hydroxide for high-sensitivity LC-MS; 35, 50, 75, 100, and 150 mm × 0.3 mm column dimensions; stainless steel construction; <i>BIO</i> .

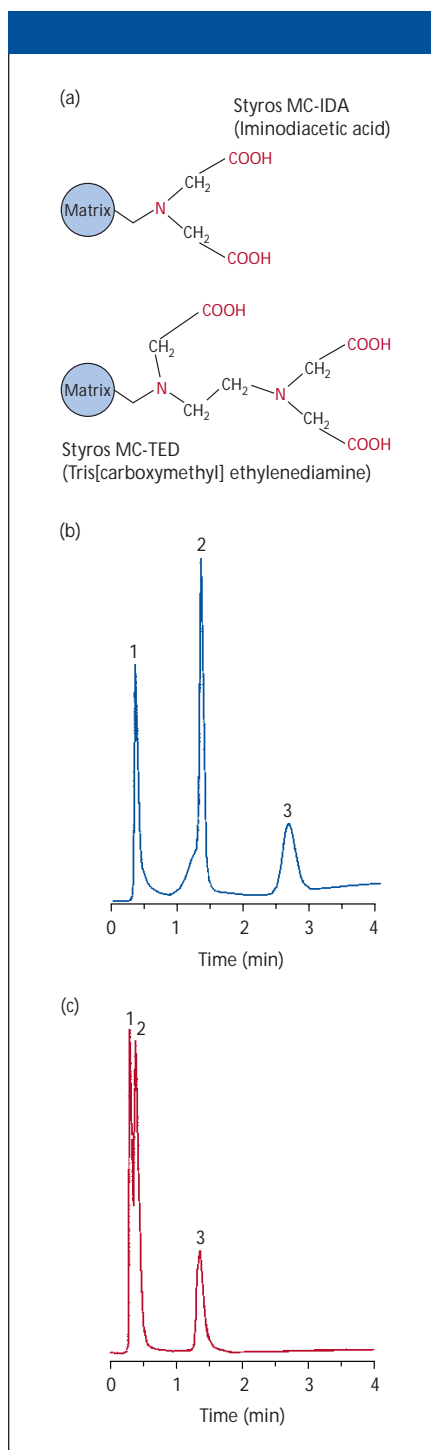


Figure 3: Metal chelate affinity HPLC to modify selectivity for protein samples. Shown are (a) the structures of Styros MC-IDA and MC-TED and separations obtained using (b) a 50 mm × 4.6 mm Styros MC-IDA column loaded with Cu⁺⁺ (50 μmol/mL) and (c) a 50 mm × 4.6 mm Styros MC-TED column loaded with Cu⁺⁺ (50 μmol/mL); mobile phase A: 20 mM sodium phosphate-1 M sodium chloride (pH 7.5); mobile phase B: 20 mM sodium phosphate-1 M ammonium chloride (pH 7.3); flow rate: 2.5 mL/min; gradient: 0–100% B in 12 column volumes; temperature: 30 °C; detection: UV at 280 nm; injection volume: 5 μL. All analytes were dissolved in 50% buffer A. Peaks: 1 = cytochrome C, 2 = lysozyme, 3 = myoglobin. (Courtesy of OraChrom.)

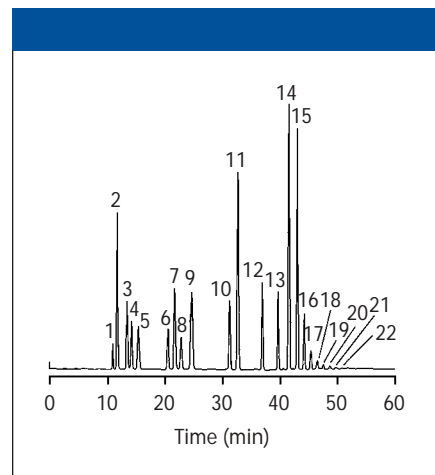


Figure 4: Separation of mono-, di-, and oligosaccharides and sugar alcohols. Column: 250 mm × 4.6 mm, 5-μm *d_p* Alltech Prevail Carbohydrate ES; mobile phase A: acetonitrile; mobile phase B: 0.04% ammonium hydroxide in water; gradient: 17–27% B in 25 min, 27–45% B in 15 min, then 45–65% B in 40 min; flow rate: 1.0 mL/min; detection: evaporative light scattering. Peaks: 1 = isoerythritol, 2 = fructose, 3 = sorbitol, 4 = mannitol, 5 = glucose, 6 = inositol, 7 = sucrose, 8 = maltitol, 9 = maltose, 10 = raffinose, 11 = maltotriose, 12 = maltotetraose, 13 = maltopentaose, 14 = maltohexaose, 15 = maltoheptaose, 16 = maltooctaose, 17 = maltononaose, 18 = maltodecaose, 19 = maltoundecaose, 20 = maltododecaose, 21 = maltotridecaose, 22 = maltotetradecaose. (Courtesy of Alltech Associates.)

requested information in advance of Pittcon 2002, thus allowing a timely report on new product introductions. For those manufacturers that would like to be considered for inclusion in Pittcon 2003 coverage, please send the name of the primary company contact, mailing address, fax number, and e-mail address to "Column Watch" Pittcon 2003, *LCGC*, 859 Willamette Street, Eugene, OR 97401.

Ronald E. Majors

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