



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 2003. In part I, he describes high performance liquid chromatography (HPLC) columns and packings for reversed-, normal-, and bonded-phase; ion-exchange; ion; and size-exclusion chromatography. He also looks at specialty HPLC columns.

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Column Watch Editor

New Chromatography Columns and Accessories at the 2003 Pittsburgh Conference, Part I

Pittcon 2003 — the 54th Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy — returns to the Orange County Convention Center in Orlando, Florida, on 9–14 March 2003. This year's event will host more than 1250 instrument manufacturers and laboratory suppliers in more than 2700 booths. In addition to attending the exposition, the conferees can listen to 1200 oral presentations, view more than 900 posters, check out 50 seminars, or attend one of 96 short courses.

Pittcon remains the most important annual international analytical exhibition at which companies introduce their latest instruments, instrument accessories, columns, sample preparation products, and other consumables. Because many past attendees have purchased one or more new products within three months after attending the show, most exhibitors attempt to maximize their booth traffic to meet as many potential customers as possible.

The purpose of this two-part report is to provide information about many of the new separation consumables and accessory products that will be displayed at Pittcon 2003. In some cases, products that were introduced during 2002 but after Pittcon 2002 may be included for reasons of completeness (1,2). The information in these columns is based upon manufacturers' responses to a questionnaire mailed in December 2002. Because of space limitations and the fact that some of the manufacturers did not respond to the questionnaire, this report cannot be considered an exhaustive listing of all new products that will be introduced in Orlando. However, over the years, these Pittcon introduction summaries have provided a good source of information that would be difficult for one person 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 will cite specific information about bioapplications where appropriate. Because HPLC microbore columns (1.0–2.1 mm i.d.) now are numerous, I will include them in the individual modes; however, capillary (<1.0-mm i.d.) and nano columns (<0.15-mm i.d.) are included in the specialty HPLC columns category because they require special instrumentation to obtain their best performance.

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

Trends and Highlights

General: Again this year, the largest number of products will be introduced for the separation, sample preparation, and liquid chromatography–mass spectrometry (LC–MS) measurement of biomolecules, currently the most active areas in chromatographic research and applications. Specialty HPLC columns for chiral; protein, peptide, and amino acid; and phospholipid analysis, as well as turbulent flow chromatography and LC–MS represent the biggest category of entries. Also well repre-

Companies Listed in This Column

Advanced Separation Technologies (Astec), Whippany, New Jersey
 Agilent Technologies, Inc., Wilmington, Delaware
 Alltech Associates, Inc., Deerfield, Illinois
 BioChrom Labs, Inc., Terre Haute, Indiana
 Bischoff Chromatography, Leonberg, Germany
 Chiral Technologies, Inc., Exton, Pennsylvania
 Cluzeau-Info-Labo, Sainte Foy La Grande, France
 Cohesive Technologies Inc., Franklin, Massachusetts
 Daicel Chemical Industries, Ltd., Tokyo, Japan
 Daiso Co. Ltd., Osaka, Japan
 Dionex Corp., Sunnyvale, California
 ES Industries, West Berlin, New Jersey
 Grace Vydac, Hesperia, California
 Hamilton Co., Reno, Nevada
 Higgins Analytical, Inc., Mountain View, California
 Isco, Inc., Lincoln, Nebraska
 Jordi FLP, Bellingham, Massachusetts
 LC Packings, A Dionex Co., Amsterdam, The Netherlands
 Macherey-Nagel GmbH & Co. KG, Düren, Germany
 Merck KGaA, Darmstadt, Germany
 MicroSolv Technology Corp., Long Branch, New Jersey
 Micro-Tech Scientific, Vista, California
 Millipore Corp., Billerica, Massachusetts
 Nacalai Tesque, Kyoto, Japan
 New Objective, Inc., Woburn, Massachusetts
 Nomura Chemical Co., Ltd., Seto, Japan
 Optimize Technologies, Inc., Oregon City, Oregon
 OraChrom, Woburn, Massachusetts
 Phenomenex, Torrance, California
 Pickering Laboratories, Mountain View, California
 Polymer Laboratories, Amherst, Massachusetts
 Restek Corp., Bellefonte, Pennsylvania
 Scivex/Upchurch Scientific, Oak Harbor, Washington
 Selerity Technologies, Inc., Salt Lake City, Utah
 SeQuant AB, Umeå, Sweden
 SGE Inc., Austin, Texas
 Shiseido Co., Ltd., Tokyo, Japan
 Supelco, Bellefonte, Pennsylvania
 Thermo Electron Corp., Runcorn, United Kingdom
 Tosoh Bioscience LLC, Montgomeryville, Pennsylvania
 Varian, Inc., Palo Alto, California
 Waters, Milford, Massachusetts
 ZirChrom Separations Inc., Anoka, Minnesota

Table 1: Series of high performance liquid chromatography columns at Pittcon 2003

Product Name	Supplier	Analytical	Preparative	Guard	Bulk	Modes	Phases	Comments
apHera columns	Astec	Yes	No	Yes	No	Reversed and normal phase	C4, C8, C18, amino	Polyvinyl alcohol-based polymeric packings; 50, 150, and 250 mm × 2.0 and 4.6 mm column dimensions; matched 10-mm-long guard columns available.
Chiralpak Microbore columns	Chiral Technologies	Yes	No	No	No	Reversed phase, chiral	Amylose tris(3,5-dimethyl carbamate), [(S)- α -methylbenzyl carbamate], cellulose tris(3,5-dimethylphenyl carbamate), and cellulose tris(4-methylbenzoate)	A family of 150 mm × 2.1 mm microbore columns packed with the most useful chiral phases from Daicel; coated chiral polysaccharide-based polymer; 5- μ m particles; primarily developed for reversed-phase LC-MS separations, minimizes solvent use and improves sensitivity in limited-sample situations.
Cogent columns	MicroSolv Technology	Yes	No	Yes	No	Reversed and normal phase	C2, C4, C8, C18, phenyl, pentafluorophenyl, divinylbenzene, polar-embedded, cyano, amino, diol, silica, chiral	Features Super-Link system finger-tightened cartridge concept or conventional compression endfittings; 2.0, 3.0, and 4.6 mm × 20–250 mm column dimensions; 4- and 5- μ m particles available; 120-Å porosity; Aclarity products offer low surface area and a wide-pore silica (200 Å) alternative; LC-MS versions available; hQ = high quality; HPS = high-purity silica; endcapped and nonendcapped versions of reversed-phase columns.
Daisogel SP-100 columns	Daiso	No	No	No	Yes	Reversed and normal phase	C1, C4, C8, C18, silica	Spherical particle sizes available in 3-, 5-, 7-, and 10- μ m d_p ; 100-Å pore size; highly retentive, highly loaded phases; available as bulk packing only.
Discovery Zr-PS columns	Supelco	Yes	Yes	Yes	No	Reversed phase, ion exclusion	Mixed mode	Zirconia-based packing material; coated stationary phases: polystyrene, polybutadiene, or carbon monolayer (including one with C18 bonding) with some on exchange character; 3- and 5- μ m particle diameter; 300-Å pore size; pH 1–14 range; stable at temperatures as high as 200 °C; 5–25 cm × 2.1–4.6 mm column dimensions.
Intelligent Speed (IS) columns	Waters	Yes	No	No	No	Reversed phase	Range of phases	Short columns (20 mm) with microbore (2.1-mm i.d.) and analytical dimensions (3.0-, 3.9-, and 4.6-mm i.d.); 2.5-, 3.5-, and 5- μ m particle sizes; available in full range of Waters phases, including hybrid phases; recommended for high-throughput drug discovery and for easy conversion of older methods to shorter columns and high-speed separations using conventional HPLC and MS systems.
Pinnacle DB columns	Restek	Yes	Yes	Yes	Yes	Reversed and normal phase	C8, C18, cyano, silica	Base-deactivated silica that has undergone pore smoothing to improve mass transfer characteristics; monomeric endcapping; 150-Å pore diameter; 5- μ m particle size; 1–50 mm i.d. available.
Pursuit columns	Varian	Yes	Yes	Yes	No	Reversed phase	C8, C18, C30, diphenyl, MS	Microbore columns available; 3-, 5-, and 10- μ m particle sizes; 200-Å pore diameter; C18 column has 14.5% carbon coverage.
Sprite columns	Higgins Analytical	Yes	No	No	No	Reversed and normal phase	C8, C18, cyano, phenyl	Microbore columns; 10, 20, and 40 mm × 2.1 mm column dimensions; small, direct-connection format to HPLC sample or switching valves; useful for ballistic gradients, LC-MS, and fast LC; PEEK†-titanium construction; 18% carbon loading for C18; low-bleed phases.
Swift Monolithic columns	Isco	Yes	Yes	No	No	Reversed phase, anion exchange, cation exchange	PS-DVB*, quaternary, DEAE‡, carboxymethyl	PS-DVB- (reversed phases) and polymethacrylate (ion-exchange phases)-based monoliths with various functionalities; polymeric materials have wide pH stability range; columns of glass and PEEK-lined stainless steel construction; 50 mm × 4.6 mm and 100 mm × 10 mm column dimensions; low operating pressure with high flow rates possible; <i>BIO</i> .
Type C silica columns	MicroSolv Technology	Yes	No	Yes	No	Reversed and normal phase	Silica, cholesterol	Type C silica is based on silica hybrid chemistry (Figure 1); the bare silica hybrid packing can be used in reversed-phase chromatography; by a change in organic-water ratio, the columns work like normal-phase column; the bonded cholesterol phase is liquid-crystal-like and undergoes temperature- and solvent-induced phase transition, which causes selectivity changes; low bleed for LC-MS work.

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

†PEEK = polyetheretherketone.

‡DEAE = diethylaminoethyl.

sented will be capillary and nano LC columns for situations in which sample mass is limited and that require greater sensitivity and for LC-MS and LC-MS-MS. In addition, sample preparation products in solid-phase extraction (SPE), protein digestion, and on-line protein removal applications will be featured.

HPLC columns: Reversed-phase HPLC maintains its dominance, and manufacturers will display a significant number of reversed-phase columns that have various

types of embedded polar functional groups, perfluorinated phases, coated zirconia, and particle sizes smaller than 2 μ m. Nano and capillary separation columns also will be displayed. Monolithic columns will appear in both silica and polymeric chemistries, and large-scale preparative monoliths will allow high flow rates and high mass throughputs. As far as I am able to determine, no irregularly shaped silica-gel packed columns will be introduced in analytical sizes this year, so unless I state other-

wise, assume that all the packings are spherical in nature. The number of specialty columns is at an all-time high; some are unique ion chromatography and carbohydrate columns.

Gas chromatography: GC columns to debut this year are highlighted by new low-bleed phases that provide enhanced sensitivity and lower baseline drift during temperature programming. Many application-specific columns will be introduced in the petrochemical, environmen-

tal, drug testing, and food and flavor markets.

Sample preparation: For the first time, the number of polymeric SPE phase introductions will exceed the silica-based SPE introductions. SPE cartridges still will be most apparent, but more 96-well SPE and filtration plates are slated for introductions for automation systems. Several integrated sample preparation and autosampler systems will be shown, including a valving system designed to make column switching a more useful tool.

Accessories: New accessories for LC-MS and ion chromatography, a leak detector, a flowmeter, a low-volume canister for air sampling for GC, and a clever disposable microdialysis tube are among the highlights at Pittcon 2003.

HPLC Columns and Packings 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 covers those new series of HPLC columns displayed at Pittcon 2003. In some cases, the series are major extensions of existing products in the companies' offerings but they cover an entire mode or group of phases; in other cases, the series are entirely new to the market.

The most interesting new family of products introduced at Pittcon 2003 is the Type C silica phases from MicroSolv. Part of the Cogent family, Type C silica is a silica hybrid and is characterized by the absence of silanol surface groups (Figure 1). The bare Type C silica column can be used for both reversed- and normal-phase chromatography. The Si-H bond can be further reacted to form Si-C bonded phases such as the company's UDC Cholesterol phase, a liquid-crystal-like phase that will undergo temperature- and solvent-induced phase transitions with accompanying selectivity changes.

Microbore HPLC columns are among the more popular introductions this year. This observation is not just for new series but also for the individual modes. The microbore columns that will be introduced generally have 2.0- or 2.1-mm inner diameters, some in very short (< 50 mm) column lengths packed with 3- and 5- μm d_p packing materials. The advantage of these columns is their ability to interface with MS systems because they should operate at lower flow rates than those compatible with larger-inner diameter analytical columns. With microbore columns and especially with capillary columns, specialized capillary LC instruments or modifications of existing HPLC instruments often are necessary to use these small columns optimally. Other advantages of these smaller-inner diameter columns are increased sensitivity in situations in which sample mass is limited and solvent savings because of the low flow rate requirements.

Another significant introduction is the Swift monolithic column from Isco. Isco joins several other monolith producers in providing these columns for analytical and small-scale preparative work. Similar to other polymeric monoliths, these columns show that low operating pressures with high linear velocities give good overall efficiency. Figure 2 provides an example of a rapid separation of protein standards in 20 s using a Swift reversed-phase column. Reversed-phase and anion- and cation-exchange columns are available.

Reversed-Phase Chromatography Columns

As usual, many new reversed-phase chromatography columns are scheduled to be introduced at Pittcon 2003 (see Table II). In fact, if I include the reversed-phase chromatography columns to be introduced under the series (Table I) and specialty (Table III) categories, this year's 44 new products or lines of products indicate the continuing strong popularity of the technique. Of the new packings, 70% are silica-based, 21% are polymer-based materials, and 9% are based upon other materials such as zirconia, porous glass, hybrids, or an unspecified material. Some additional silica and polymeric monolithic columns will be displayed. Most of the packings are either 3- or 5- μm particles (28% and 52%, respectively). Again, the C18 phase is the most popular chemistry, followed by C8, but several new reversed-phase chromatography materials are making appearances on the scene and providing users alternative selectivities for more-difficult separations. Many reversed-phase chromatography columns are specially devoted to defined applications such as protein separations (especially those with 300- \AA pores or those packed into 75- μm i.d. capillaries for proteomics studies), so I placed them in the specialty columns category (Table III).

Because of the large number of reversed-phase chromatography materials, I again

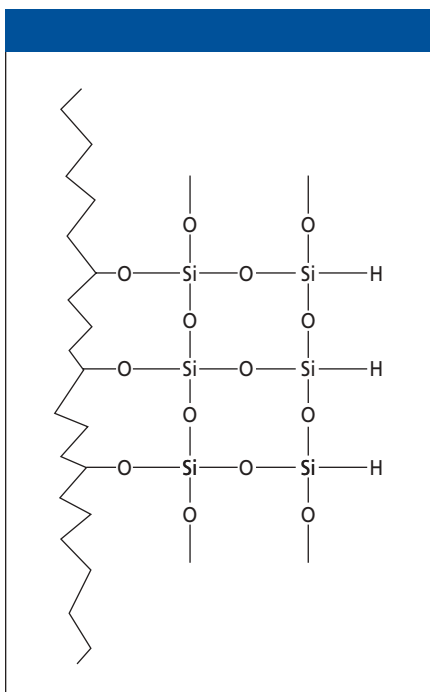


Figure 1: Structure of Type C silica. (Courtesy of MicroSolv Technology Corp.)

have classified the phases according to their suggested chemistry or the application emphasis of the manufacturer based on the provided information. For example, a regular category means that the manufacturer did not specify any unusual characteristics or applications. Another popular category, the highly aqueous phases (polar-embedded or aqueous type) in Table II are recommended for use with mobile phases containing low concentrations of organic solvent and as much as 100% water. Most of these phases incorporate (embed) a polar (nonionic) functional group (amide, ether, urea, amine, or carbamate) somewhere in the bonding process into the alkyl-bonded-phase chain itself or endcap the silica surface with a hydrophilic reagent, sometimes called a polar endcapping. The phase primarily is hydrophobic but with hydrophilic

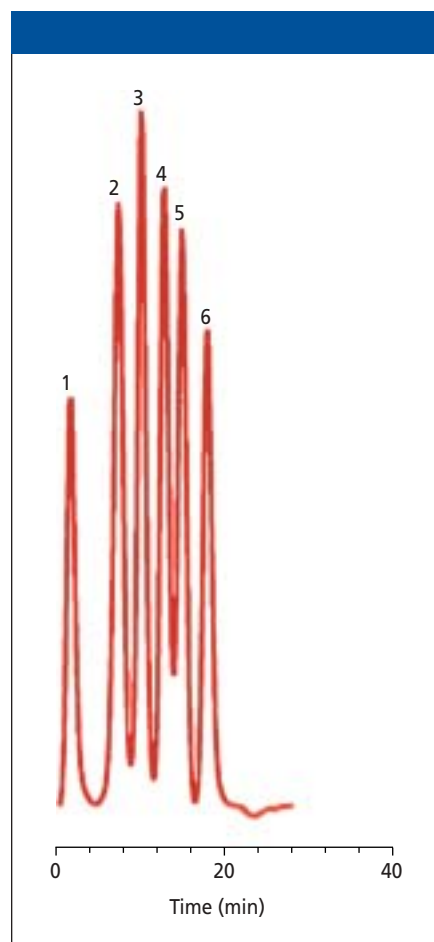


Figure 2: Separation of protein standards on a polymeric monolithic column. Column: 50 mm \times 4.6 mm Swift reversed-phase monolith; mobile phase A: water with 0.15% trifluoroacetic acid; mobile phase B: acetonitrile with 0.15% trifluoroacetic acid; gradient: 42–90% B in 0.35 min; flow rate: 10 mL/min. Peaks: 1 = nonretained proteins, 2 = ribonuclease, 3 = cytochrome, 4 = bovine serum albumin, 5 = carbonic anhydrase, 6 = ovalbumin. (Courtesy of Isco, Inc.)

groups near the surface or in the alkyl chain that can be wetted with polar eluents. Phase wetting and phase collapse were the subjects of two recent "Column Watch" installments, so they will not be discussed further in this column (3,4).

I have spotted several interesting reversed-phase chromatography columns that will debut at Pittcon. ES Industries' perfluorinated phase shows strong π - π interactions with aromatic analytes and is recommended for the separation of geo-

metric isomers, which can be difficult to separate with C18 bonded phases. The Cosmosil 5PYE and 5NPYE columns (Nacalai Tesque) possess special functionality that is unlike typical C18 columns. The selectivities were quite different, and these

columns might prove useful for situations in which C18 doesn't quite provide a needed separation.

Merck has extended its monolithic column line to include a C8 chemistry available only in 4.6-mm i.d. columns. The

ZirChrom EZ column includes a polybutadiene phase coated on a zirconia particle. This column is Lewis base-deactivated and can be used without mobile-phase additives to separate Lewis bases. Waters' Atlantis dC18 column achieves enhanced

retention of polar compounds without the extreme retention of nonpolar compounds. In addition, the phase resists dewetting and allows the use of 100% aqueous mobile phase. Agilent Technologies' Zorbax STM (sub-2- μ m d_p) StableBond C18 column

Table II: Reversed-phase chromatography columns at Pittcon 2003

Product Name	Supplier	Type	Base Material	Functional Group	Particle Size (μ m)	Pore Size (\AA)	Comments
Astec RPC columns	Astec	Highly aqueous	Silica	C8, C18	3.5, 5	Not specified	Columns can be used under 100% aqueous conditions; especially recommended for LC-MS applications; 50, 100, 150, and 250 mm \times 2.0 mm and 150 mm \times 3.0 mm column dimensions; 20 mm \times 2.0 and 4.0 mm guard columns available.
Atlantis dC18 columns	Waters	Highly aqueous	Silica	C18	3, 5	100	Difunctionally bonded C18; endcapped; 1.6- μ mol/m ² coverage; recommended for analyzing polar compounds in highly aqueous mobile phases without extreme nonpolar compound retention and without tailing of amine-containing bases; LC-MS compatible; available in analytical, microbore, capillary, and preparative sizes; cartridge design with 20-250 mm lengths; 10- and 20-mm-long guard columns; bulk packing available.
Capcell Pak C18 ACR columns	Shiseido	Regular	Silica	C18	5	80	Polymer coated with 18% carbon coverage; recommended for analysis at low pH and for LC-MS application; analytical, microbore, capillary, and preparative sizes available; guard columns available; standard compression fittings.
Capcell Pak C18 AQ columns	Shiseido	Highly aqueous	Silica	C18	5	80	Recommended for the separation of polar analytes in low organic concentration mobile phases, even 100% aqueous phases; also recommended for LC-MS applications; packing is polymer coated with 11% carbon coverage; analytical, microbore, capillary, and preparative sizes available; guard columns available.
Chromegabond FSP Plus columns	ES Industries	Regular	Silica	Perfluorinated phenyl	3, 5, 10, 16	120	Recommended for analyzing isomers; strong π - π interactions due to the nature of the stationary phase; available in analytical, microbore, capillary, and preparative sizes; guard columns available; stainless steel and PEEK construction.
Chromolith Performance RP8e	Merck	Monolithic	Silica monolith	C8	Not applicable	See comments	Monolithic polymeric silica column with endcapped C8 phase; 100 mm \times 4.6 mm column dimensions; 11% carbon coverage; 20,000- \AA macropores and 130- \AA mesopores; high-speed analysis with low back pressure. columns
Cosmosil 5C18-PAQ columns	Nacalai Tesque	Highly aqueous	Silica	C18	5	120	Recommended for separations of hydrophilic compounds in highly aqueous mobile phases (as much as 100% water) without phase collapse; 11% carbon coverage, polymeric-linked C18; 150 and 250 mm \times 4.6 mm column dimensions; 10 mm \times 4.6 mm guard columns available.
Develosil ODS-SR-3 columns	Nomura Chemical	High coverage	Silica	C18	3	80	18% carbon coverage; available in a wide variety of dimensions and guard columns and cartridge designs; recommended for LC-MS applications because the columns must be used with the more MS-friendly higher organic solvent concentrations; highly retentive.
Develosil RP-Aqueous-AR columns	Nomura Chemical	Long chain	Silica	C30	3, 5	140	Trifunctional long-chain phase with 18% carbon coverage; more stable under acidic conditions than other C30 phases; both polar and nonpolar compounds — sugars, carotenoids, and fullerenes — can be separated; wide variety of dimensions, guard columns, and cartridge designs available.
HiRes C18 columns	Cohesive Technologies	Regular	Silica	C18	10	120	Recommended for analyzing neutral and acidic pharmaceuticals; 50 mm \times 1.0 mm column dimensions; enhanced sensitivity and reduced solvent consumption compared with 2.1-mm and larger inner diameter columns; stainless steel and PEEK construction.
Hypurity Aquastar columns	Thermo Electron	Highly aqueous	Silica	C18	5	180	Ultrapure silica base material; polar endcapped; recommended for chromatography of hydrophilic basic molecules in highly aqueous mobile phases of as much as 100% water; capillary to preparative column sizes available; guard columns available.
Nucleodur 100-5 C8 ec columns	Macherey-Nagel	Regular	Silica	C8	5	100	Densely coated monofunctional silane chemistry; available in analytical, microbore, and preparative sizes; ChromCart cartridge column design; guard columns and bulk packing available.
Nucleodur C8 Gravity columns	Macherey-Nagel	Base deactivated	Silica	C8	5	100	Densely coated monofunctional silane chemistry; available in analytical, microbore, and preparative sizes; ChromCart cartridge column design; guard columns and bulk packing available.
Piccolo columns	Higgins Analytical	Regular	Silica	C18	5	120	Microbore column for short analytical or guard column applications; other applications include desalting, trapping, and trace enrichment; 10 mm \times 1.0 mm column dimensions; 18% carbon coverage; low-bleed phase recommended for LC-MS applications.
Polyamide columns	Jordi	High stability	Polyamide	Polyamide	5	10,000	Hydrophilic polymeric bead with pH 0-14 stability; can withstand high pressures and temperatures; recommended for protein separations; pore size determined by injection of polystyrene standards; 150 mm \times 4.6 mm column dimensions; bulk packing available; <i>BIO</i> .
Prevail C18 Select columns	Alltech	Highly aqueous	Silica	C18	3, 5, 10	100	Recommended for the separation of acidic and basic compounds at neutral pH; compatible with 100% aqueous mobile phases; selectivity different compared with normal C18 columns; 50, 150, and 250 mm \times 1-22 mm column dimensions.
Purospher Star RP-18e columns	Merck	Regular	Silica	C8	3	120	Microbore columns recommended for high-sensitivity separations in limited-sample situations; 150 mm \times 0.5 and 1 mm column dimensions; endcapped packing has 17.5% carbon coverage; based on silica with 320-m ² /g surface area.
Stability BS C17 columns	Cluzeau-Info-Labo	Regular	Silica	C17	5	100	Basic quaternary amine spacer (BS = basic spacer) between C3 and C14 moieties; reversed-phase and anion-exchange mixed modes; 250-m ² /g surface area; 150 mm \times 2 mm column dimensions; microbore and capillary sizes also available; recommended for chromatographic analysis of glutathion with MS detection.
Stability Phenyl columns	Cluzeau-Info-Labo	Regular	Silica	Phenyl	5	100	220-m ² /g silica surface area; 250 mm \times 2 mm column dimensions; microbore and capillary columns also available; recommended for analyzing Busulfan in plasma.
ZirChrom-EZ columns	ZirChrom Separations	Mixed mode	Zirconia	Polybutadiene with cation exchange	3, 5	300	Packing has pH 1-10 range; can withstand temperatures as high as to 50 °C; range can be extended to pH 12 and to 100 °C by using certain mobile-phase additives; recommended for pharmaceutical method development especially for Lewis acid analysis and LC-MS; unique selectivity; available in analytical, microbore, capillary, and preparative dimensions; cartridge design.
Zorbax STM columns	Agilent Technologies	Regular	Silica	C18	<2 μ m	80	Cartridge design has 15 and 30 mm \times 2.1 and 4.6 mm dimensions; standard compression fitting design has 50 mm \times 2.1 and 4.6 mm dimensions; available in StableBond (nonendcapped and recommended for low pH applications) and Eclipse XDB (endcapped) chemistries; designed to provide twice the efficiency of 3.5- μ m d_p packings; recommended for high-speed separations and LC-MS applications.

provides double the efficiency of a typical 3–3.5 μm d_p packing material, so a short column provides extremely rapid reversed-phase chromatography separations.

Normal Bonded-Phase and Adsorption Chromatography Columns

Some of this year's normal-phase columns were already covered as part of the new HPLC column series in Table I. Normal-phase chromatography still has its place in separations laboratories, especially for water-sensitive samples, for analytes that are insoluble in water, for certain geometric isomers difficult to separate by reversed-phase chromatography, and for class separations. 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, in addition to those previously covered in Table I, two other normal-phase products will be shown at Pittcon 2003.

With the Chromolith Performance Si monolith introduction, Merck now offers the bare monolithic column as a stand-alone product for adsorption and normal-phase work. Previously, the company sold only a reversed-phase version. The monolithic column has a standard 100 mm \times 4.6 mm dimension. The monolithic column has both macropores (20,000 Å) and mesopores (130 Å). A big advantage of the silica monolith is its low pressure drop at high flow rates, which saves time for analysis and column reequilibration after a gradient.

Another new normal bonded-phase to be introduced is the Chromegabond Diol-HD column from ES Industries. Typically, a diol phase has hydrophilic properties yet doesn't show the stronger adsorption characteristics of bare silica gel. The 3-, 5-, 10-, and 16- μm silica-gel particles can be purchased in bulk separately. The pore-size average is approximately 120 Å. A wide variety of column dimensions — including preparative, analytical, capillary and nano LC, guard, and cartridge columns — are available in stainless steel or polyether-etherketone (PEEK) column hardware. Columns with inner diameters from 1 cm to 30 cm are available for preparative work. This high-density phase offers an alternative to silica gel for preparative chromatography.

Ion-Exchange and Ion Chromatography Columns

Five new ion-exchange and ion chromatography columns — two cation-exchange columns and three anion-exchange columns — will debut at Pittcon 2003. Continuing the trends of the past few years, polymer-based columns are still in the majority, and only one silica-based product will be displayed. Polymeric columns have a larger pH operating range and can be used and cleaned with harsh reagents such as sodium hydroxide, which is favored by biochemists to remove residual proteins. Both PEEK and stainless steel columns and fittings are used. For ion chromatography applications, PEEK hardware seems to be preferable because any potential trace cations that might be leached from the stainless steel are absent. Most of the ion-exchange offerings this year are recommended for the separation of small molecules and ions, although some are related to the separation of biomolecules.

Ion chromatography is used to separate trace inorganic and low molecular weight organic anions and cations using suppressed conductivity detection and isocratic elution. Both Alltech and Dionex plan to introduce anion analytical and guard columns for the determination of 10 anions, including 3 oxyhalides, in drinking water and other water samples according to U.S. Environmental Protection Agency (EPA) Method 300.1. The 250 mm \times 4.0 mm Alltech Novosep A-2 anion column is constructed of PEEK and packed with a quaternary amine-functionalized polyvinyl alcohol phase that is suited to the requirements for EPA Methods 300.0 and 3176.0. The 5- μm d_p packing provides improved peak shape and good peak efficiency.

The 250 mm \times 2 and 4 mm Dionex IonPacAS18 column is based on the company's 7- μm d_p bead, which is synthesized with cross-linked ethylvinylbenzene 55% cross-linked with divinylbenzene (DVB) that has a neutral hydrophilic latex layer with chemically bonded linkage arms functionalized with alkanol quaternary ammonium. The column is used with an eluent generator that automatically generates a potassium hydroxide mobile phase that provides low backgrounds and thus lower detection limits than the more common carbonate mobile phases.

Carbohydrates can be separated at high pH in the ionized form using amperometric detection. Dionex's new 150 mm \times 3

mm CarboPac PA20 anion-exchange column, which has 6.5- μm particles that also are based upon the same cross-linked phase described above, is functionalized with a difunctional quaternary ammonium functionalized latex and can be used for separating mono- and disaccharides in glycoprotein therapeutic compounds, foods, and beverages. A new disposable gold electrode for the company's amperometric detector coupled with this resin technology provides long-term retention time and peak area stability.

Dionex and Phenomenex plan to display cation-exchange columns. Dionex's IonPac CS17 column also is based upon the company's patented base resin technology, but in this column the resin is surface-grafted with a carboxylic acid, which makes it a weak cation-exchange phase. Its main application area is for the gradient separation of polyvalent and hydrophobic amines using eluent-generated methanesulfonic acid as a mobile phase. Many low molecular weight amines can be separated without organic solvents by using conductivity and MS detection in series. For very hydrophobic amines, the column can be used with some acetonitrile and alcohols.

The Phenomenex Luna SCX column is packed with a 5- and 10- μm d_p silica-based packing that has phenyl strong cation-exchange sulfonic acid functionality with 0.15 mequiv/g coverage. The column, available in 316 stainless steel, comes in a variety of dimensions, both analytical and preparative scale. Its main applications are for analyzing nitrogen-containing compounds and various drugs of abuse, peptide mapping, and serving as the initial column in two-dimensional chromatography of protein digests. The column can be used in the pH 2–7 range.

Hamilton, a longtime producer of resin-based ion exchange columns, expanded its PRP-X100 line of anion-exchange columns with the addition of trimethylammonium functionalized 7-, 5-, and 3- μm d_p PS-DVB particles (100 Å) packed into 150 mm \times 4.6 mm and other size columns. Its exchange capacity is 0.19 mequiv/g. This packing also is sold in bulk. The PRP-X100 column is one of the few anion columns that can successfully analyze ethylenediaminetetraacetic acid (EDTA) as a metallic complex in various sample matrices.

Text continues on page 258.

Table III: High performance liquid chromatography specialty columns at Pittcon 2003

Product Name	Supplier	Type	Applications	Base Material	Functional Group	Particle Diameter d_p (μm)	Pore Size (\AA)	Comments
Accelerated Lithium cation-exchange columns	Pickering Laboratories	Ion exchange	Amino acid analysis	PS-DVB	Sulfonic acid	5	Not specified	Macroreticular resin recommended for high-speed separation of physiological amino acids; 80 mm \times 5.5 mm column dimensions; stainless steel construction; <i>BIO</i> .
Acclaim 300 C18 columns	Dionex	Reversed phase	Protein and peptide analysis	Silica	C18	3	300	Cartridge column with guard column; 50 and 150 mm \times 2.1 and 4.6 mm; stainless steel construction; endcapped; 8% carbon coverage; 1.4- $\mu\text{mol}/\text{m}^2$ surface area; 0.8-mL/g pore volume; recommended for LC-MS applications; <i>BIO</i> .
Atlantis HILIC columns	Waters	Hydrophilic interaction	Polar pharmaceutical analysis	Silica	Not specified	3, 5	100	HILIC = hydrophilic interaction chromatography; recommended for analyzing very polar molecules such as small pharmaceuticals and metabolites or when users desire orthogonal selectivity compared with that of reversed-phase chromatography; might provide enhanced electrospray ionization MS response in high-throughput screening; 20–250 mm column lengths; guard columns available; stainless steel construction; bulk packing available.
Biphasic PicoFrit columns	New Objective	LC-MS	Protein and proteomic analysis	Silica	C18, strong cation exchange	Not specified	100, 300	Fused-silica 100 mm \times 75 μm nanobore column packed with cation exchanger (3-cm length) followed by reversed-phase media (ProteoPep C18, 7-cm length); tip of column interfaces directly into MS inlet; integral frit reduces tip clogging; <i>BIO</i> .
Capellini columns	Higgins Analytical	Reversed phase	Micro and nano LC	Silica	C18	5	120	Capillary and nano LC columns of PEEK-titanium and fused-silica construction; 30, 50, 100, and 150 mm \times 0.075 and 0.15 mm column dimensions; symmetrical design permits mobile-phase flow in either direction to allow routine backflushing for multidimensional chromatography or reversed-flow washed; fused-silica column can be disassembled and reassembled without tools to cut off a contaminated or plugged section of capillary; 18% carbon coverage; low-bleed phase suitable for LC-MS applications.
Chiralpak AS-RH columns	Chiral Technologies	Chiral	Enantiomeric separations	Silica	Amylose (S)- α -phenylmethyl-carbamate	5	1000	Recommended for separating aqueous-based chiral compounds under reversed-phase conditions; phase provides unique selectivity; 20% carbon coverage; 150 mm \times 4.6 mm column dimensions.
Chirobiotic VAG columns	Astec	Chiral	General chiral compound analysis	Silica	Vancomycin aglycon	5	100	This phase is complementary to other Chirobiotec phases in that it reverses the elution order of enantiomers; can be used in reversed- or normal-phase solvent systems; 90–100 $\mu\text{mol}/\text{m}^2$ phase coverage; 100, 150, and 250 mm \times 2.0 and 4.6 mm column dimensions; guard column available; cartridge design; bulk packing available.
Cosmosil 5 HIC columns	Nacalai Tesque	Hydrophobic interaction	Protein analysis, desalting	Silica	Diol	5	300	Recommended for separating delicate bioactive proteins and one-step desalting and separating outsalted precipitated proteins; can load ammonium sulfate precipitated crude protein extracts; 50 mm \times 4.6 mm column dimensions; 7% carbon coverage; <i>BIO</i> .
Cosmosil 5PYE and 5NPYE columns	Nacalai Tesque	Reversed phase	LC-MS	Silica	See comments	5	120	PYE = 2-(1-pyrenyl)ethyl; NPE = nitrophenylethyl; PYE columns have 18% carbon coverage; NPE columns have 9% carbon coverage; 100, 150, and 250 mm \times 2.0 mm column dimensions; unique selectivities unlike C18.
Cyclone HTLC columns	Cohesive Technologies	Turbo flow columns	Turbulent flow chromatography	Polymer or silica	See comments	60	100	Three stationary phases; 60- \AA pores; 50 mm \times 0.5 mm column dimensions; recommended for extracting nonpolar (HTLC hydrophobic polymer, P version hydrophobic polymer with polar modification), moderately polar (P version), and polar (PolarPlus version C18 bonded silica with polar group) pharmaceuticals from biological matrices; stainless steel and PEEK construction materials; smaller-inner diameter columns produce enhanced sensitivity and lower solvent consumption than 1.0-mm versions.
Develosil LAL columns	Nomura Chemical	Reversed phase	Trace aluminum determination	Silica	Modified C8	5	140	Column is recommended for separating aluminum in parts-per-billion concentrations in parenteral solution, urine, and serum with detection using a fluorescence detector; the aluminum is complexed with lumogallion and separated as a fluorescent chelate on the column; 10% carbon coverage; 100 mm \times 6.0 mm column.
Discovery Bio PolyMA-SCX and Bio PolyMA-WAX columns	Supelco	Polymeric	Protein and peptide analysis	Polymethacrylate	DEAE, sulfopropyl	5	1000	Hydrophilic surface chemistry of base material; available in strong cation exchange (sulfopropyl) and weak anion exchange (DEAE) chemistries; 0.3-mequiv/g ion-exchange capacity for both columns; pH 1–13 and pH 2–10 range for strong cation- and weak anion-exchange columns, respectively; can withstand temperatures as high as 50 $^{\circ}\text{C}$; <i>BIO</i> .
Everest 300 C18 columns	Grace Vydac	Reversed phase	Protein and peptide analysis	Silica	C18	5	300	Packing based on ultrahigh-purity silica (Type B); analytical, microbore, capillary, nano, and preparative columns available; guard column available; <i>BIO</i> .
EZ:Faast LC kit	Phenomenex	Amino acid analysis	Physiological fluid amino acid analysis	Proprietary reversed-phase	Proprietary reversed-phase	4	80	Column can separate more than 50 aromatic and aliphatic amino acids in approximately 20 min; kit includes everything needed to prepare and analyze 384 samples in blood, plasma, urine, cerebrospinal fluid, and protein hydrolysates; SPE phase is an amino acid binding phase and is packed in a pipette tip; no plasma protein or urine urea removal is necessary; <i>BIO</i> .
High Temperature columns	Selerity Technologies	Reversed phase	High-temperature separations	Silica	C8	3	100	This polycarbosilane bonded phase is hydrolytically stable from temperatures ranging from ambient to higher than 100 $^{\circ}\text{C}$; recommended for elevated-temperature and temperature-gradient programmed HPLC; column dimensions: 10 and 15 cm \times 2.1 and 4.6 mm; stainless steel construction.
Hydrocell NRD 2 columns	Biochrom Labs	Biomolecules	DNA fragment analysis	PS-DVB	PS-DVB	3	Multipores	Recommended for ion-pairing reversed-phase chromatography; multiporous structure allows separations of both small and large DNA fragments; 50 and 150 mm \times 2.1 mm column dimensions; stainless steel construction; guard and preparative columns available; <i>BIO</i> .
IntegraFrit Trap columns	New Objective	LC-MS	Guard column, trap, analytical column	Silica	C18, cation exchange	Not specified	80, 100, 300	Small 25 mm \times 75 or 100 μm columns with ultralow volume (<2 nL) IntegraFrit as outlet frit; titanium inlet frit; ProteoPep, BioBasic, and AquaSil C18 packings as well as strong cation exchanger available; can be placed in injection loop for sample preparation, use as nanobore rapid separation column, or as guard column; cartridge column with finger-tightened fittings.
MacroSep Fluoroalkyl columns	ES Industries	Reversed phase	Hydrophobic protein analysis	Silica	Short-chain perfluorinated	3, 5, 10, 16	1000	Unique selectivity for hydrophobic proteins compared with that of C18 columns; analytical, microbore, capillary, and preparative columns available; guard column available; stainless steel or PEEK construction; <i>BIO</i> .

Table III: High performance liquid chromatography specialty columns at Pittcon 2003, continued

Product Name	Supplier	Type	Applications	Base Material	Functional Group	Particle Diameter d_p (μm)	Pore Size (\AA)	Comments
MacroSep FSP columns	ES Industries	Reversed phase	Protein analysis	Silica	Perfluorinated phenyl	3, 5, 10, 16	300, 1000	Stationary phase provides unique selectivity for proteins compared with that of C18 columns; analytical, microbore, capillary, and preparative columns available; guard column available; stainless steel or PEEK construction; <i>BIO</i> .
Monolithic Nano capillary columns	LC Packings	Reversed phase	Proteomic analysis	PS-DVB	PS-DVB	Monolith	N/A	Monolithic polymer in 50 mm \times 0.20 mm column; fused-silica and PEEK construction; performs high-speed separations for LC-MS; elution with 2-s peak at half-height; nano LC system recommended for best performance; <i>BIO</i> .
Montage antibody purification kit	Millipore	Affinity column	Antibody purification	Porous glass	Protein A, protein G	74–125	Not specified	Prepacked spin column for fast purifications; can be used directly with centrifuge; no columns to pack nor pumps to use; uses Prosep-A and Prosep-G media; can purify 15–35 mg of antibody in less than 1 h; <i>BIO</i> .
Opti-Pak Capillary Trap columns	Optimize Technologies	Trapping column	Biological sample analysis	Silica, DVB	Various	Not specified	Not specified	Packed-bed capillary columns; 2.54 mm \times 0.35, 0.50, and 0.75 mm column dimensions; can be used in multidimensional LC systems with switching valves to direct trapped analytes to waste and to additional separation columns; columns connect directly to any 10-32 port with zero dead volume connection; phases include C18, C18 polar embedded, strong cation exchange, mixed mode, DVB-strong cation exchange, and polymethacrylate; <i>BIO</i> .
Pholipidec columns	Astec	Normal phase	Phospholipid analysis	Silica	Diol	5	100	Recommended for separating phospholipids and related compounds; specially certified for analyzing soy lecithin extracts; 100- $\mu\text{mol}/\text{m}^2$ phase coverage; 250 mm \times 4.6 mm cartridge column dimensions; integral guard column.
Pinnacle II PAH columns	Restek	Environmental	Polyaromatic hydrocarbon analysis	Silica	Proprietary	5	110	Recommended for separating 16 polyaromatic hydrocarbons (PAHs) components according to U.S. EPA Method 8310; 2.1- and 4.6-mm i.d. columns; stainless steel construction.
PLRP-5 columns	Polymer Laboratories	Protein column	Proteomic analysis	PS-DVB	PS-DVB	3	100, 300	Short columns in small diameters available for rapid resolution LC-MS; 5 and 15 cm \times 2.1 and 1.0 mm column dimensions; 100- \AA porosity recommended for peptide separations and 300- \AA porosity for protein separations; high retentivity; pH 1–14 range; can be sterilized; <i>BIO</i> .
Poroshell 300SB columns	Agilent Technologies	Superficially porous reversed-phase	High-speed protein analysis	Silica	C3, C8, C18	5	300	Superficially porous silica particle allows rapid mass transfer of intact proteins at fast flow rates; different alkyl chemistries for different hydrophobicities and selectivities; recommended for low pH applications; can withstand temperatures as high as 90 $^\circ\text{C}$; 75 mm \times 1.0 and 2.1 mm column dimensions; stainless steel construction; <i>BIO</i> .
ProntoSIL 120-5 Chiral AX QD 1 columns	Bischoff Chromatography	Chiral	Acidic chiral compound analysis	Silica	Quinidine	5,10	120	Columns can be used in reversed- and normal-phase modes; complementary selectivity to the QN 1 version column; 150–250 mm \times 2.0–20.0 mm column dimensions; guard columns available; bulk material available for preparative work.
ProntoSIL 120-5 Chiral AX QN 1 columns	Bischoff Chromatography	Chiral	Acidic chiral compound analysis	Silica	Quinine	5,10	120	Columns can be used in reversed- and normal-phase modes; complementary selectivity to the QD 1 version column; 150–250 mm \times 2.0–20.0 mm column dimensions; guard columns available; bulk material available for preparative work.
ProSphere P columns	Alltech Associates	Reversed phase	Small protein and polypeptide analysis	Methacrylate	Methacrylate	7	Not specified	Polymeric phase with pH 1–13 range; recommended for working with hydrophobic proteins and peptides because of the hydrophilic nature of packing; 50, 150, and 250 mm \times 0.075, 0.15, 0.30, 2.1, 4.6, and 10 mm column dimensions; stainless steel or PEEK construction; guard columns available; <i>BIO</i> .
ProteCol capillary columns	SGE	Capillary column	Proteomic analysis, drug discovery, and LC-MS	Silica	C18	3	120	Fused-silica-lined PEEK tubing packed with high carbon load C18; integrated column and connecting tubing provides zero dead volume to minimize band spreading; available with 0.15- and 0.30-mm i.d.; <i>BIO</i> .
Protein capillary columns	Micro-Tech Scientific	Proteomics	Protein, peptide, and tryptic digest analysis	Silica	C4, C8, C18	3–10	100–1000	Fused-silica packed 50–500 μm i.d. columns recommended for capillary LC-MS-MS and the separation and characterization of proteins, peptides, and tryptic digests; guard columns available; cation and anion exchange columns available; can also be used for capillary electrochromatography; <i>BIO</i> .
SCX Capillary Sample Trap columns	Scivex/Upchurch Scientific	Trapping column	Biological sample analysis	Unspecified	Strong cation exchange	5	85	Columns connect directly to Upchurch capillary sample trap column hardware with 350- μm o.d. fused silica, PEEK, or polytetrafluoroethylene perfluoroalkoxy alkane HP Plus capillary tubing; 2.5 cm \times 100 μm capillary dimensions; recommended for separating, concentrating, and purifying biological samples for LC-MS analysis; C18 packing on 300- \AA silica also available; 0.1- μg sample loading capacity; includes a 1- μm Nanofilter capsule with a titanium or stainless steel frit; <i>BIO</i> .
SCX HTLC columns	Cohesive Technologies	Turbulent flow column	Turbulent flow chromatography	Silica	Sulfonic acid	50	60	Recommended for extracting very polar pharmaceuticals from biological matrices, especially cationic solutes not extracted by reversed-phase chromatography; 50 mm \times 1.0 mm column dimensions; stainless steel and PEEK construction.
Styros HIC columns	OraChrom	Hydrophilic interaction	Protein separations	PS-DVB-methacrylate	Phenyl, butyl, ether	Not specified	Gigaporous	Recommended for high-speed separation of biomolecules in high salt concentration without altering the biological activity; the monolithic matrix is coated and functionalized; wide pH range; can be cleaned in place with harsh reagents such as sodium hydroxide; 1–250 mm \times 0.20–0.20 mm column dimensions; stainless steel or PEEK construction; <i>BIO</i> .
Styros Protein A columns	OraChrom	Affinity column	Antibody purification	PS-DVB-methacrylate	Protein A	Not specified	Gigaporous	Recommended for high-speed purification of most human, rabbit, cow, guinea pig, dog, and pig IgG; the monolithic matrix is coated and functionalized; wide pH range; can be cleaned in place with harsh reagents such as sodium hydroxide; 1–250 mm \times 0.20–0.20 mm column dimensions; stainless steel or PEEK construction; <i>BIO</i> .
ZIC-HILIC columns	SeQuant	Hydrophilic interaction	Peptide analysis	Silica	Sulfonic and quaternary amine	3, 5, 10	200	Zwitterionic stationary phase takes advantage of weak electrostatic interactions with charged analytes; recommended for work with cationic and hydrophilic peptides as well as carbohydrates, proteins and digests, and polar compounds; 50–250 mm \times 4.6 mm analytical column dimensions; microbore, capillary, and preparative columns also available; stainless steel or PEEK construction; <i>BIO</i> .

Size-Exclusion Chromatography Columns

The only company that plans to introduce size-exclusion columns this year is Tosoh Bioscience with its TSKgel Super HZ and Super AW column lines. These products are new-generation high performance size-exclusion chromatography packings based on small-particle technology. The HZ products are designed specifically for nonaqueous gel-permeation chromatography polymer characterization and separation. These columns are packed with 3- μm PS-DVB particles in 150 mm \times 4.6 mm and 150 mm \times 6.0 mm beds. With five pore sizes, these columns can analyze molecular weights ranging from approximately 10^3 to 10^6 . The columns with smaller pore sizes also can separate monomers, oligomers, and polymer additives. Because the column dimensions are smaller than those of standard high-resolution columns, the columns provide faster analysis speeds and lower solvent usage. Three mixed-bed columns are available for scouting experiments and preventing the shearing of high molecular weight polymers.

The TSKgel Super AW columns are packed with highly cross-linked hydrophilic polymethacrylate particles. Five pore sizes are available. The series includes one mixed-bed column. Depend-

ing upon the pore size, the particle sizes vary from 4 μm to 9 μm . The standard column dimension is 150 mm \times 6.0 mm. The packings are compatible with both aqueous and polar organic mobile phases, and solvent exchange is possible without swelling or shrinkage. Because of the smaller particle sizes and column dimensions, the solvent consumption is approximately one-third and the separation times are roughly one-half of those associated with earlier high performance size-exclusion chromatography columns.

Specialty HPLC Columns

Specialty columns are HPLC columns that have been developed for specific separations that are difficult to achieve using a standard column. However, manufacturers sometimes use a standard column but test it specifically for a certain class or certain compounds and provide a recommended set of chromatographic conditions. In some cases, the specialty column comes as part of a total-solution kit with reagents, standards, and a method. Most specialty columns will come with a test chromatogram from an analysis performed at the factory before shipment, and some are guaranteed. Table III shows the 36 specialty columns that will be presented at Pittcon 2003. Silica gel-based specialty

columns outnumbered polymer-based columns 2:1.

The largest single category of specialty columns is those designated for the separation of biomolecules, primarily proteins, peptides, and amino acids. Approximately two-thirds of the specialty columns fit in this category. Several of these biochromatography columns were designed for direct and easy interfacing with MS detectors. I have included capillary, nano, and nano-trapping columns that were specifically designed for LC-MS with the specialty columns. Capillary and nano columns, with inner diameters as small as 0.075 mm, have major advantages for the small samples encountered in protein digests because they can provide good sensitivity in limited-sample cases and can be interfaced directly into the MS source. The use of two-dimensional (2-D) capillary chromatography coupled with MS is becoming an important replacement technique for 2-D gel electrophoresis. By first fractionating a peptide digest on a cation-exchange capillary with subsequent desalting (by a reversed-phase chromatography trap column), transferring fractions to a reversed-phase chromatography nanocolumn, and then transferring them to an MS or MS-MS system could become the preferred technique if the methodology proves to be rugged and reproducible.

New-generation columns capable of resolving closely related proteins will make their appearance at Pittcon 2003. The Supelco Discovery Bio PolyMA-WAX column enables the separation of human growth hormone degradation products by anion-exchange chromatography. Agilent Technologies is displaying three chemistries for its Poroshell line — C3, C8, and C18 — for the fast separations of proteins. Poroshell is a superficially porous 5- μm d_p packing that has a thin layer of stationary phase on the outer core of a solid silica sphere. Large biomolecules with small diffusion constants traverse only a short diffusion path and thus provide greater efficiency at fast flow rates than do totally porous particles. Figure 3 shows a sub-1-min rapid gradient elution chromatogram of protein standards using the Poroshell C18 column.

Phospholipids always have been among the more difficult compounds to analyze by HPLC, mainly because of detection problems. With the advent of the evaporative light-scattering detector that solved the detection problem and new columns such as Astec's Pholipidec column, the problem

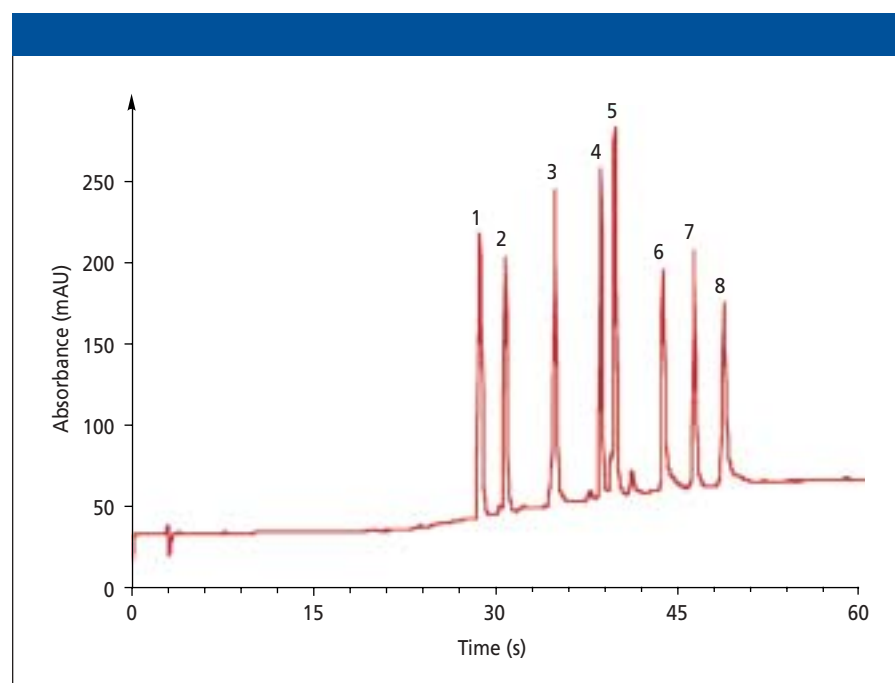


Figure 3: Rapid separation of proteins on a Poroshell 3005B-C18 column. Column: 75 mm \times 2.1 mm Poroshell 3005B-C18; mobile phase A: 0.1% trifluoroacetic acid; mobile phase B: 0.07% trifluoroacetic acid in acetonitrile; gradient: 5–100% B in 1 min; flow rate: 3 mL/min; temperature: 70 °C; pressure: 260 bar; detection: UV absorbance at 215 nm. Peaks: 1 = angiotensin II, 2 = neurotensin, 3 = ribonuclease, 4 = insulin, 5 = lysozyme, 6 = myoglobin, 7 = carbonic anhydrase, 8 = ovalbumin. (Courtesy of Agilent Technologies.)

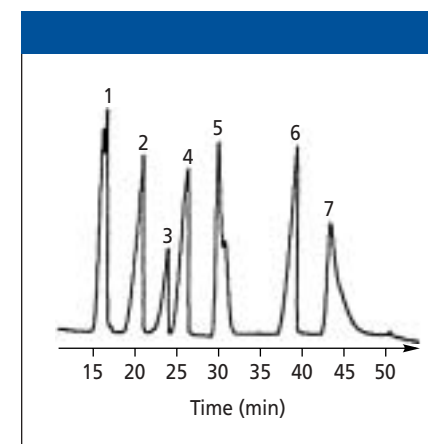


Figure 4: Separation of phospholipids on a Pholipidec specialty column. Column: 250 mm \times 4.6 mm Pholipidec; mobile-phase gradient: chloroform-methanol-ammonia to chloroform-methanol-water-ammonia; flow rate: 1.0 mL/min; detection: evaporative light scattering. Peaks: 1 = phosphatidylethanolamine, 2 = phosphatidylinositol, 3 = lyso phosphatidylethanolamine, 4 = phosphatidylserine, 5 = phosphatidylcholine (lecithin), 6 = phosphatidic acid, 7 = lyso phosphatidylcholine. (Courtesy of Astec.)

appears to be solved. Figure 4 depicts a chromatogram of seven key phospholipids that were separated using a gradient detection. The selectivity of the stationary phase is based upon a unique diol functionality. The chain exceeds three carbons, which results in the increased stability of the phase. The surface of the siloxane is cross-linked to protect the silane linkage from attack from the ammonia most commonly used in mobile phases for the separation of phospholipids. An important application of the Pholipidec column is the analysis of soy lecithin extracts.

Other significant applications columns are those designed for chiral compound analysis, for hydrophobic and hydrophilic interaction chromatography, and for the turbulent flow chromatography of drugs in biological fluids.

Acknowledgment

I would like to thank the manufacturers and distributors that kindly furnished the requested information in advance of Pittcon 2003, thus allowing a timely report of new product introductions. For those

manufacturers who would like to be considered for inclusion into Pittcon 2004 coverage, please send the name of the primary company contact, mailing address, fax number, and e-mail address to "Column Watch" Pittcon 2004, LCGC, 859 Willamette Street, Eugene, OR 97401.

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