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Advantages of the Pirkle-Type Chiral Stationary Phases

Universal Solvent Capability

The entire family of Regis' Pirkle-Type Chiral Stationary Phases (CSP's) can be used in ***BOTH*** normal and reversed-phase solvents. Due to the fact that all of the Pirkle-Type CSP's are covalently bonded, the columns can tolerate all commonly used mobile phase combinations.

Column Durability

Another advantage of covalent bonding is column durability. Listed below are a few distinct benefits associated with the Pirkle-Type CSP's:

- Long lasting columns
- Bonded selector will not leach off the silica gel
- Can tolerate sample overload
- Can utilize strong solvents for cleaning
- Columns are fully reversible
- Compatible in SFC and SMB applications

Ability to Invert Elution Order

All of the Pirkle-Type CSP's are available in both enantiomeric forms. This allows the Chromatographer to invert the elution order of the enantiomers by simply switching columns. This advantage is essential when determining enantiomeric purity when the trace enantiomer should elute before the major. Elution order is also important in preparative chromatography because when the desired enantiomer elutes first, purity and production efficiency increases.

Chromatographic Efficiency

Unlike most Chiral columns on the market, Pirkle-Type Chiral HPLC columns show excellent chromatographic efficiency. The high density of binding sites allows larger amounts of sample to be injected without major changes in column performance.

Ease of Scale-up

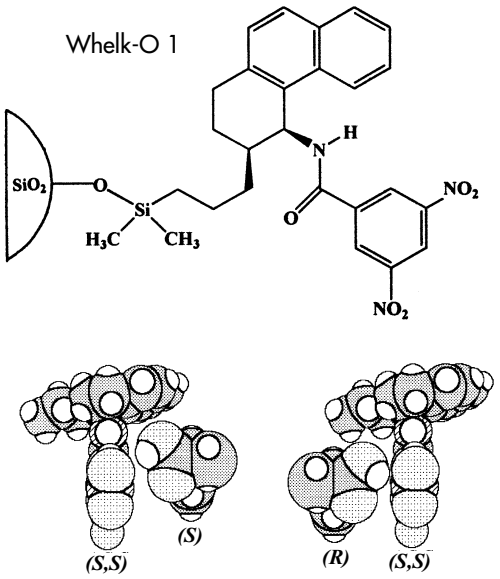
Pirkle-Type CSP's were designed to allow the Chromatographer to scale-up their separation from analytical to preparative in a linear fashion. Regis uses the highest grade silica gels available on the market today. The 5-micron CSP's are bonded on Exsil®. Our 10-micron and 16-micron CSP's are bonded on Kromasil®. Synthesis of the chiral selectors, bonding of the different CSP's, and column production is all performed by Regis in one facility. This allows Regis total control over the product line. This also allows Regis to perform special requests for the customer, including custom bonding and custom column packing.

Pirkle Chiral Stationary Phases

The Pirkle-Concept Chiral Stationary Phases generally fall into three classes: π-electron acceptor/π-electron donors, the π-electron acceptors and the π-electron donors. With Pirkle Phases, chiral recognition occurs at binding sites. Major binding sites are classified as π-basic or π-acidic aromatic rings, acidic sites, basic sites, and steric interaction sites. Aromatic rings are potential sites for π-π interactions. Acidic sites supply hydrogens for potential intermolecular hydrogen bonds-the hydrogen is often an amido proton (N-H) from an amide, carbamate, urea, or amine. Basic sites, such as π-electrons, sulfinyl or phosphinyl oxygens, and hydroxy or ether oxygens, may also be involved in hydrogen bond formation. Steric interactions may also occur between large groups.

π-Electron Acceptor/π-Electron Donor Phases

- WHELK-O 1
- WHELK-O 2
- ULMO

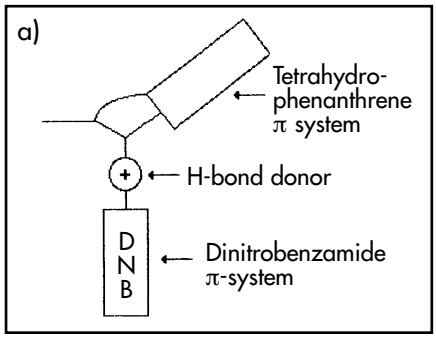


The latest and most revolutionary addition to the Pirkle-Concept series is the π-electron acceptor/π-electron donor phase. This concept is an innovative incorporation of both π-acceptor and π-donor characteristics, resulting in a phase that can be used for a wide variety of compound groups.

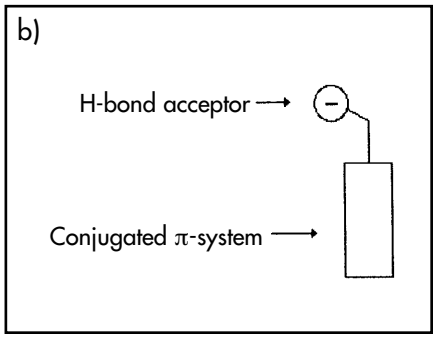
WHELK-O 1

The Whelk-O 1 Chiral Stationary Phase is based on 1-(3,5-Dinitrobenzamido)-1,2,3,4,-tetrahydrophenanthrene. This phase allows separation of underivatized racemates from a number of families including amides, epoxides, esters, ureas, carbamates, ethers, aziridines, phosphonates, aldehydes, ketones, carboxylic acids, and alcohols.

The Whelk-O 1 was originally designed for the separation of underivatized non-steroidal anti-inflammatory drugs (NSAIDs). This π-electron acceptor/π-electron donor phase exhibits an extraordinary degree of generality, allowing resolution of a wide variety of underivatized racemates. This broad versatility observed on the Whelk-O 1 column, compares favorably with polysaccharide-derived chiral stationary phases. In addition, because of the Whelk-O 1's covalent nature, this chiral phase is compatible with all commonly used mobile phases, including aqueous systems-a distinct advantage over polysaccharide-derived chiral stationary phases. Other advantages include column durability, excellent efficiency, elution order inversion allowing availability of both enantiomeric forms, and excellent preparative capacity.



a) Schematic diagram showing key functional groups of the Whelk-O 1 involved in chiral recognition.

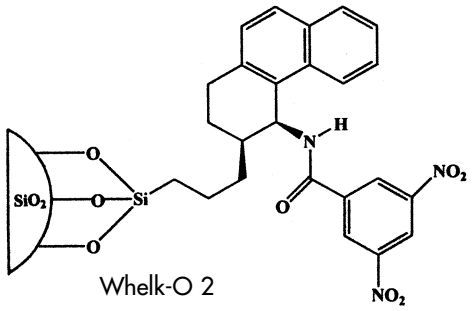


b) Schematic diagram showing generalized structure of analytes which are resolved on the Whelk-O 1.

WHELK-O 2

The Whelk-O 2 is the covalent trifunctional version of the Whelk-O 1. The Whelk-O 2 retains the same chiral selector but modifies the support to silica from a monofunctional linkage to a trifunctional. In most cases, the enantioselectivity remains the same allowing the separation of the analogous family of racemates as does the Whelk-O 1.

Whelk-O 2 was designed to enhance the stability of the stationary phase due to hydrolysis while using strong organic modifiers such as trifluoroacetic acid. The Whelk-O 2 is ideal for preparative separations since the material is bonded on 10 μm 100 Å spherical Kromasil silica. This allows the preparative chromatographer to perform method development on their analytical column and immediately scale-up to larger diameter columns.

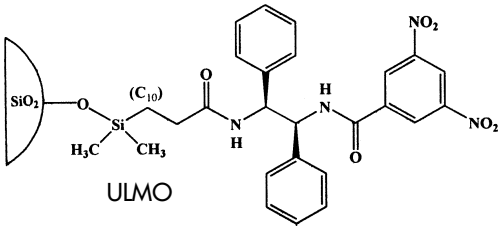


Whelk-O 2

ULMO

The ULMO chiral stationary phase was developed by Austrian Researchers, Uray, Lindner, and Maier. This CSP has a general ability to separate the enantiomers of many racemate classes, and is particularly good at separating the enantiomers of aryl carbinols.

The ULMO CSP is based on a 3,5-Dinitrobenzoyl derivative of diphenylethylene-diamine.



ULMO

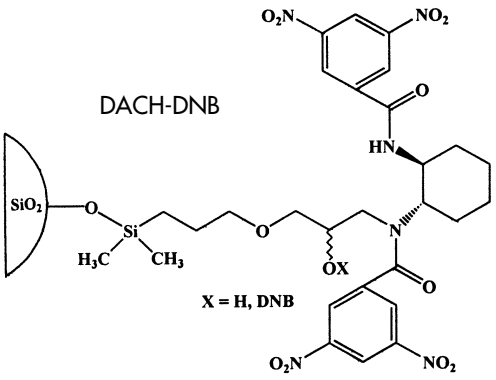
π-Electron Acceptor Phases

- DACH-DNB
- Pirkle 1-J
- α-Burke 2
- β-Gem 1
- Leucine
- Phenylglycine

The π-electron acceptor Pirkle Chiral Stationary Phases can be used to separate a wide range of enantiomers without derivatization, as demonstrated for the following classes of solutes: secondary benzyl alcohols, mandelic acid analogs, α-hydroxy-α-aryl phosphates, α-tetralol analogs, propranolol analogs, β-hydroxy-aryl sulfoxides, alkyl-aryl sulfoxides, diaryl sulfoxides, aryl-substituted cyclic phthalides, aryl-substituted lactams, aryl-substituted succinimides, aryl-substituted hydantoins, bi-β-naphthol and its analogs, and α-aryl acetamides.

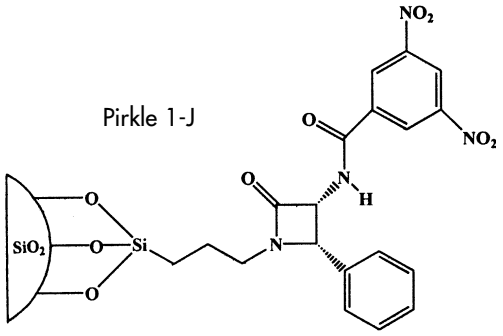
DACH-DNB

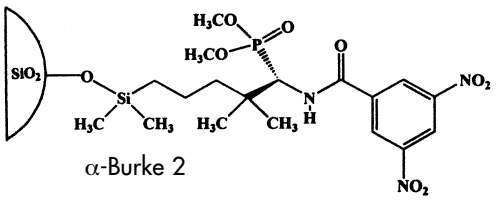
The innovative DACH-DNB CSP was designed by Italian chemists Dr. Francesco Gasparrini, Misiti and Villani at Rome University "La Sapienza." The DACH-DNB CSP; which contains the 3,5-dinitrobenzoyl derivative of 1,2-diaminocyclohexane, has been found to resolve a broad range of racemate classes including amides, alcohols, esters, ketones, acids, sulfoxides, phosphine oxides, selenoxides, phosponates, thiophosphineoxides, phosphineselenides, phosphine-boranes, β-lactams, organo-metallics, atropisomers and heterocycles.



PIRKLE 1-J

The Pirkle 1-J CSP is based on 3-(3,5-Dinitrobenzamido)-4-pheny-β-lactam. This unusual β-lactam structure significantly alters its molecular recognition properties. The Pirkle 1J is useful for the direct separation of underivatized β-blocker enantiomers. It can also be used for the separation of the enantiomers of arylpropionic acid NSAID's as well as other drugs.

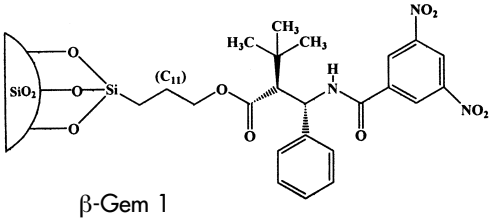




α-Burke 2

α-BURKE 2

The α-Burke 2 phase, first prepared by J. A. Burke III, a graduate student of Dr. Pirkle, is derived from dimethyl N-3,5-dinitro-benzoyl-α-amino-2,2-dimethyl-4-pentenyl phosphonate. The α-Burke 2 has been specifically designed to directly separate the enantiomers of β-blockers without chemical derivatization, but this chiral phase is not limited solely to the separation of β-blocker enantiomers. It also resolves the enantiomers of many compounds separated on π-acceptor Pirkle type chiral stationary phases.

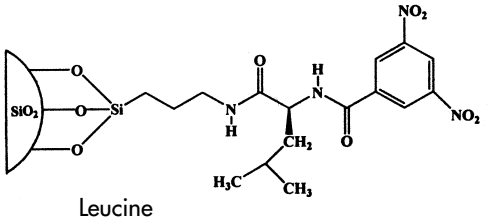


β-Gem 1

β-GEM 1

β-Gem 1 is a π-acceptor chiral stationary phase and is derived from N-3,5-dinitrobenzoyl-3-amino-3-phenyl-2-(1,1-dimethylethyl)-propanoate.

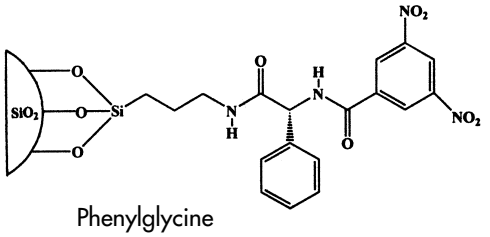
For a great many analytes, this chiral phase considerably outperforms its widely used analog, phenylglycine. It can separate anilide derivatives of a wide variety of chiral carboxylic acids, including nonsteroidal anti-inflammatory agents.



Leucine

LEUCINE

The leucine CSP is based on the 3,5-dinitrobenzoyl derivative of leucine. This π-acceptor phase demonstrates enhanced enantioselectivities for several classes of compounds, including benzodiazapines.



Phenylglycine

PHENYLGLYCINE

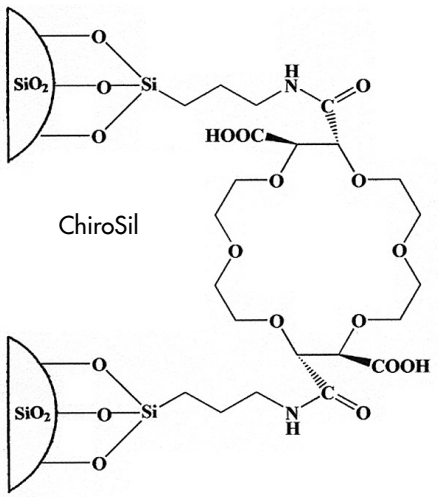
Phenylglycine is based on the 3,5-dinitrobenzoyl derivative of phenylglycine.

This CSP resolves a wide variety of compounds which contain π-basic groups. These include: aryl-substituted cyclic sulfoxides, bi-β-naphthol and its analogs, α-indanol and α-tetralol analogs, and aryl-substituted hydantoins.

Protein-Based Chiral Stationary Phases

Regis Technologies carries a line of protein-based chiral columns manufactured by ChromTech AB, United Kingdom. For additional product information and a Protein-Based Chiral Stationary Phase application guide, please contact Regis directly.

- Chiral AGP (α-glycoprotein)
- Chiral CBH (cellobiohydrolase)
- Chiral HSA (human serum albumin)



ChiroSil

RStech Corporation ChiroSil® RCA(+) and SCA(-) 18Crown-Ether Chiral Stationary Phases

- ChiroSil RCA(+)
- ChiroSil SCA (-)

Developed by RStech Corporation in Daejeon, Korea, the ChiroSil phase is the newest addition to our chiral line of columns. This phase is prepared by a covalent trifunctional bonding of (+) or (-)-(18-Crown-6)-tetracarboxylic acid as the chiral selector.

This phase which is available in analytical as well as preparative columns, is an excellent choice for the separation of amino acids and compounds containing primary amines.

Like our other line of columns, this phase is highly durable, has universal solvent compatibility, and has the ability to invert elution order.

As described above, Regis' Chiral columns can be used to separate a wide variety of enantiomers in numerous compound groups. Please refer to the Product List on page 7 for particular column types, sizes, configurations and product numbers. Consult the application separation data section that begins on page 8 for information regarding specific chiral separations on a wide variety of compounds. See Application Indexes on page 87.

PRODUCT	PARTICLE SIZE	COLUMN DIMENSIONS	PRODUCT#
(R,R)-Whelk-O 1	5 µm, 100 Å	25 cm x 4.6 mm	786201
(R,R)-Whelk-O 1	5 µm, 100 Å	25 cm x 10.0 mm	786202
(R,R)-Whelk-O 1	5 µm, 100 Å	25 cm x 30.0 mm	786205
(S,S)-Whelk-O 1	5 µm, 100 Å	25 cm x 4.6 mm	786101
(S,S)-Whelk-O 1	5 µm, 100 Å	25 cm x 10.0 mm	786102
(S,S)-Whelk-O 1	5 µm, 100 Å	25 cm x 30.0 mm	786105
(R,R)-Whelk-O 1	10 µm, 100 Å	25 cm x 4.6 mm	786515
(R,R)-Whelk-O 1	10 µm, 100 Å	25 cm x 10.0 mm	786525
(R,R)-Whelk-O 1	10 µm, 100 Å	25 cm x 21.1 mm	786535
(R,R)-Whelk-O 1	10 µm, 100 Å	50 cm x 21.1 mm	786545
(R,R)-Whelk-O 1	10 µm, 100 Å	25 cm x 30.0 mm	786708
(R,R)-Whelk-O 1	10 µm, 100 Å	25 cm x 50.0 mm	786709
(R,R)-Whelk-O 1	10 µm, 100 Å	50 cm x 30.0 mm	786713
(R,R)-Whelk-O 1	10 µm, 100 Å	50 cm x 50.0 mm	786710
(S,S)-Whelk-O 1	10 µm, 100 Å	25 cm x 4.6 mm	786615
(S,S)-Whelk-O 1	10 µm, 100 Å	25 cm x 10.0 mm	786625
(S,S)-Whelk-O 1	10 µm, 100 Å	25 cm x 21.1mm	786635
(S,S)-Whelk-O 1	10 µm, 100 Å	50 cm x 21.1 mm	786645
(S,S)-Whelk-O 1	10 µm, 100 Å	25 cm x 30.0 mm	786702
(S,S)-Whelk-O 1	10 µm, 100 Å	25 cm x 50.0 mm	786703
(S,S)-Whelk-O 1	10 µm, 100 Å	50 cm x 30.0 mm	786716
(S,S)-Whelk-O 1	10 µm, 100 Å	50 cm x 50.0 mm	786704
(R,R)-Whelk-O 2	10 µm, 100 Å	25 cm x 4.6 mm	786315
(R,R)-Whelk-O 2	10 µm, 100 Å	25 cm x 10.0 mm	786325
(R,R)-Whelk-O 2	10 µm, 100 Å	25 cm x 21.1 mm	786335
(R,R)-Whelk-O 2	10 µm, 100 Å	50 cm x 21.1 mm	786345
(R,R)-Whelk-O 2	10 µm, 100 Å	25 cm x 30.0 mm	786727
(R,R)-Whelk-O 2	10 µm, 100 Å	25 cm x 50.0 mm	786728
(R,R)-Whelk-O 2	10 µm, 100 Å	50 cm x 30.0 mm	786732
(R,R)-Whelk-O 2	10 µm, 100 Å	50 cm x 50.0 mm	786729
(S,S)-Whelk-O 2	10 µm, 100 Å	25 cm x 4.6 mm	786415
(S,S)-Whelk-O 2	10 µm, 100 Å	25 cm x 10.0 mm	786425
(S,S)-Whelk-O 2	10 µm, 100 Å	25 cm x 21.1mm	786435
(S,S)-Whelk-O 2	10 µm, 100 Å	50 cm x 21.1 mm	786445
(S,S)-Whelk-O 2	10 µm, 100 Å	25 cm x 30.0 mm	786721
(S,S)-Whelk-O 2	10 µm, 100 Å	25 cm x 50.0 mm	786722
(S,S)-Whelk-O 2	10 µm, 100 Å	50 cm x 30.0 mm	786736
(S,S)-Whelk-O 2	10 µm, 100 Å	50 cm x 50.0 mm	786723
(R,R)-ULMO	5 µm, 100 Å	25 cm x 4.6 mm	787200
(R,R)-ULMO	5 µm, 100 Å	25 cm x 10.0 mm	787201
(R,R)-ULMO	5 µm, 100 Å	25 cm x 30.0 mm	787203
(S,S)-ULMO	5 µm, 100 Å	25 cm x 4.6 mm	787100
(S,S)-ULMO	5 µm, 100 Å	25 cm x 10.0 mm	787101
(S,S)-ULMO	5 µm, 100 Å	25 cm x 30.0 mm	787103
(R,R)-ULMO	10 µm, 100 Å	25 cm x 21.1 mm	787202
(R,R)-ULMO	10 µm, 100 Å	25 cm x 30.0 mm	787707
(R,R)-ULMO	10 µm, 100 Å	25 cm x 50.0 mm	787708
(R,R)-ULMO	10 µm, 100 Å	50 cm x 30.0 mm	787712
(R,R)-ULMO	10 µm, 100 Å	50 cm x 50.0 mm	787709
(S,S)-ULMO	10 µm, 100 Å	25 cm x 21.1 mm	787102
(S,S)-ULMO	10 µm, 100 Å	25 cm x 30.0 mm	787701
(S,S)-ULMO	10 µm, 100 Å	25 cm x 50.0 mm	787702
(S,S)-ULMO	10 µm, 100 Å	50 cm x 30.0 mm	787715
(S,S)-ULMO	10 µm, 100 Å	50 cm x 50.0 mm	787703

PRODUCT	PARTICLE SIZE	COLUMN DIMENSIONS	PRODUCT#
(R,R)-DACH-DNB	5 µm, 100 Å	25 cm x 4.6 mm	788101
(R,R)-DACH-DNB	5 µm, 100 Å	25 cm x 10.0 mm	788102
(R,R)-DACH-DNB	5 µm, 100 Å	25 cm x 30.0 mm	788104
(S,S)-DACH-DNB	5 µm, 100 Å	25 cm x 4.6 mm	788201
(S,S)-DACH-DNB	5 µm, 100 Å	25 cm x 10.0 mm	788202
(S,S)-DACH-DNB	5 µm, 100 Å	25 cm x 30.0 mm	788204
(R,R)-DACH-DNB	10 µm, 100 Å	25 cm x 21.1 mm	788103
(R,R)-DACH-DNB	10 µm, 100 Å	25 cm x 30.0 mm	788707
(R,R)-DACH-DNB	10 µm, 100 Å	25 cm x 50.0 mm	788708
(R,R)-DACH-DNB	10 µm, 100 Å	50 cm x 30.0 mm	788712
(R,R)-DACH-DNB	10 µm, 100 Å	50 cm x 50.0 mm	788709
(S,S)-DACH-DNB	10 µm, 100 Å	25 cm x 21.1 mm	788203
(S,S)-DACH-DNB	10 µm, 100 Å	25 cm x 30.0 mm	788701
(S,S)-DACH-DNB	10 µm, 100 Å	25 cm x 50.0 mm	788702
(S,S)-DACH-DNB	10 µm, 100 Å	50 cm x 30.0 mm	788715
(S,S)-DACH-DNB	10 µm, 100 Å	50 cm x 50.0 mm	788705
(3R,4S)-Pirkle 1-J	5 µm, 100 Å	25 cm x 4.6 mm	731044
(3R,4S)-Pirkle 1-J	5 µm, 100 Å	25 cm x 10.0 mm	731244
(3S,4R)-Pirkle 1-J	5 µm, 100 Å	25 cm x 4.6 mm	731045
(3S,4R)-Pirkle 1-J	5 µm, 100 Å	25 cm x 10.0 mm	731245
(R,R)-α-Burke 2	5 µm, 100 Å	25 cm x 4.6 mm	735035
(R,R)-α-Burke 2	5 µm, 100 Å	25 cm x 10.0 mm	735235
(S,S)-α-Burke 2	5 µm, 100 Å	25 cm x 4.6 mm	735037
(S,S)-α-Burke 2	5 µm, 100 Å	25 cm x 10.0 mm	735237
(R,R)-β-Gem 1	5 µm, 100 Å	25 cm x 4.6 mm	731043
(R,R)-β-Gem 1	5 µm, 100 Å	25 cm x 10.0 mm	731243
(S,S)-β-Gem 1	5 µm, 100 Å	25 cm x 4.6 mm	731029
(S,S)-β-Gem 1	5 µm, 100 Å	25 cm x 10.0 mm	731229
D-Leucine	5 µm, 100 Å	25 cm x 4.6 mm	731054
D-Leucine	5 µm, 100 Å	25 cm x 10.0 mm	731254
L-Leucine	5 µm, 100 Å	25 cm x 4.6 mm	731041
L-Leucine	5 µm, 100 Å	25 cm x 10.0 mm	731241
D-Phenylglycine	5 µm, 100 Å	25 cm x 4.6 mm	731021
D-Phenylglycine	5 µm, 100 Å	25 cm x 10.0 mm	731221
L-Phenylglycine	5 µm, 100 Å	25 cm x 4.6 mm	731024
L-Phenylglycine	5 µm, 100 Å	25 cm x 10.0 mm	731224
Chiral AGP	5 µm, 300 Å	10 cm x 4.0 mm	732200
Chiral AGP	5 µm, 300 Å	15 cm x 4.0 mm	732199
Chiral CBH	5 µm, 300 Å	10 cm x 4.0 mm	732350
Chiral CBH	5 µm, 300 Å	15 cm x 4.0 mm	732351
Chiral HSA	5 µm, 300 Å	10 cm x 4.0 mm	732240
Chiral HSA	5 µm, 300 Å	15 cm x 4.0 mm	732239
ChiroSil® RCA(+)	5 µm, 100 Å	15 cm x 4.6 mm	799001
ChiroSil® RCA(+)	5 µm, 100 Å	25 cm x 4.6 mm	799002
ChiroSil® SCA(-)	5 µm, 100 Å	15 cm x 4.6 mm	799101
ChiroSil® SCA(-)	5 µm, 100 Å	25 cm x 4.6 mm	799102

Bulk material is available for all Chiral Stationary Phases

For column dimensions not listed, please contact Regis

NOTE: All columns (except the protein-based columns) listed contain chiral stationary phases that are covalently bound on 5 µm or 10 µm 100 Å spherical silica. A large variety of column dimensions and/or particle sizes are available upon request.