SOLID PHASE EXTRACTION

- High recovery and concentration of analytes
- Highly purified extracts
- Fast sample preparation
- Ease of automation
- Reduction in organic solvent consumption

Effective sample preparation procedures improve analytical results irrespective of the final analytical technique used.

Solid Phase Extraction (SPE) is a powerful technique for sample preparation. It is used in a broad range of application areas, including environmental analyses, pharmaceutical and biochemical analyses, organic chemistry and food analyses.

SPE utilises a liquid-solid extraction separation principle in which a large particle sized sorbent is sealed into a small chromatographic column. The required analytes are then selectively removed from the column either before or after removal of interfering compounds.

The main objectives of SPE are removal of interfering matrix components and selective concentration and isolation of the analytes of interest. This enables improved qualitative or quantitative analyses by GC, HPLC or other chromatographic techniques. Enrichment can increase detection sensitivity by a factor of 100 to 5000, which is particularly beneficial for trace analyses. Figures 1 and 2 below illustrate the two general separation procedures.

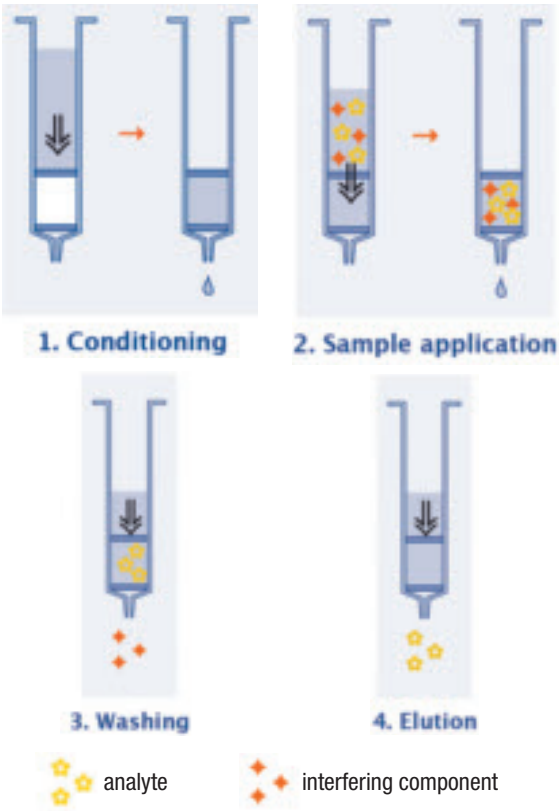


Figure 1. Retention of the analyte

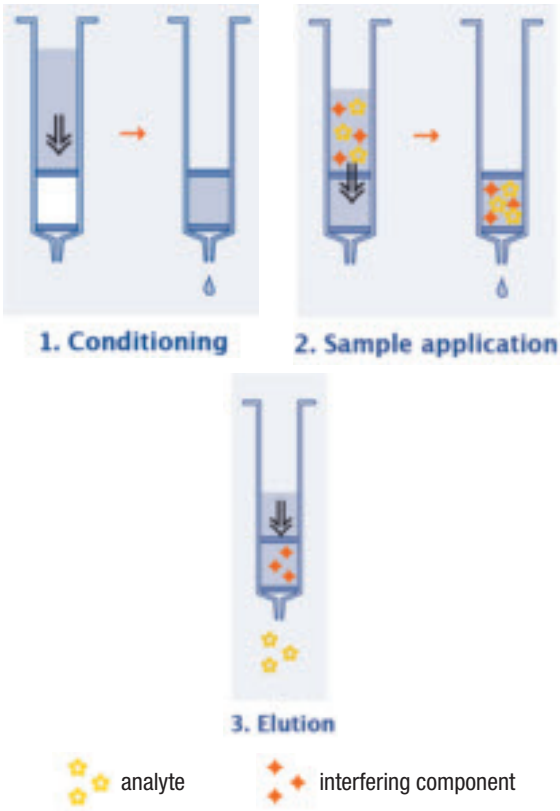


Figure 2. Retention of the interfering components

Retention of the analyte

- Analyte molecules are enriched on the adsorbent
- Interfering components and solvent molecules (matrix) are not retained
- Remaining interfering components are washed from the adsorbent
- The analyte is removed from the adsorbent by elution with a suitable solvent

Retention of interfering components

- Analyte molecules show no interaction with the adsorbent
- Interfering components and solvent molecules (matrix) are retained
- Analyte molecules are 'washed' from the adsorbent
- The solid phase is simply used to 'filter' the sample

Hichrom offers several ranges of SPE products. Please enquire about product ranges not discussed on the next few pages.

CHROMABOND® SOLID PHASE EXTRACTION PRODUCTS

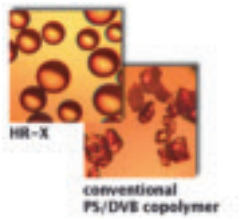
- Wide range of adsorbents
- Column and cartridge formats
- Highly reproducible recovery rates
- Silica and polymer phases

Macherey-Nagel SPE products provide rapid, economical and effective systems for sample preparation. A wide range of over 50 SPE adsorbents are available in CHROMABOND® column format (polypropylene or glass) and/or as CHROMAFIX® cartridges (sizes S, M, L (0.4 – 1.8ml)) or 96 well plates (see Figure 1 – page 302).

Adsorbents based on polymer resins (HR-X*pert*, EASY, HR-P), unbonded and surface-modified silica materials, as well as Florisil, polyamide and aluminium oxide materials are available. Please enquire regarding phases not discussed in the following pages.

CHROMABOND HR-X*pert* Series

- State-of-the-art spherical polymer
- Optimised pore structure and high specific surface area
- Robust retention mechanism even for aggressive washing procedures
- Low limits of detection even for critical matrices
- pH stability 1 - 14



CHROMABOND HR-X*pert* Family Specifications

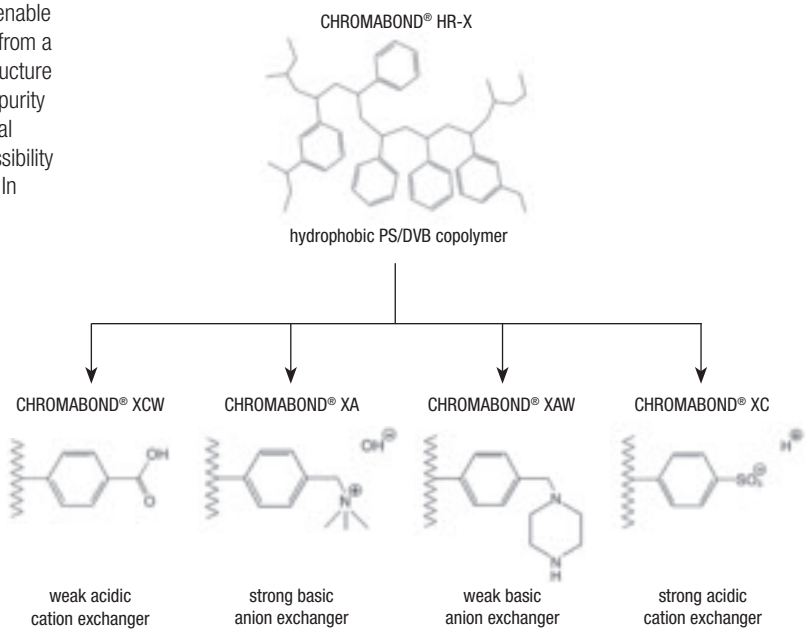
CHROMABOND Phase	Type	Particle Size (µm)	Pore Size (Å)	Specific Surface (m^2/g)	Capacity[1] (mg/g)	Applications
HR-X	RP	45, 85	55 - 60	1000	390	Neutral compounds eg. pharmaceuticals, drugs, pesticides, phenols
HR-XC	SCX	45, 85	65 - 75	800	300	Bases with pKa 2 – 10 eg. fungicides from food, melamine from milk
HR-XA	SAX	45, 85	55 - 65	850	350	Acids with pKa 2 – 8 eg. phenolic acids, acidic herbicides
HR-XCW	WCX	45, 85	50 - 60	850	350	Strong bases with pKa > 10 eg. quaternary amines
HR-XAW	WAX	45, 85	55 - 65	850	350	Strong acids with pKa < 1 eg. sulphonates, perfluorinated surfactants

[1] Caffeine in water

The CHROMABOND HR-X*pert* family comprises five polymer based RP- and mixed-mode ion-exchange phases for SPE. These enable excellent enrichment of neutral, acidic and basic compounds from a broad spectrum of application areas. The optimised pore structure leads to high loadability and low solvent consumption. High purity HR-X*pert* materials enable lower limits of detection for critical matrices, such as urine, plasma and serum and offer the possibility of more aggressive washing procedures for matrix removal. In addition to the standard 85µm particle size phases, 45µm materials are also available.

CHROMABOND HR-X*pert* development kits are available containing 10 columns of HR-X and 5 columns each of the other 4 phases (3ml/60mg or 3ml/200mg) – please contact Hichrom for details.

Chemical structures – CHROMABOND HR-X*pert* family



CHROMABOND® Solid Phase Extraction Products (continued)

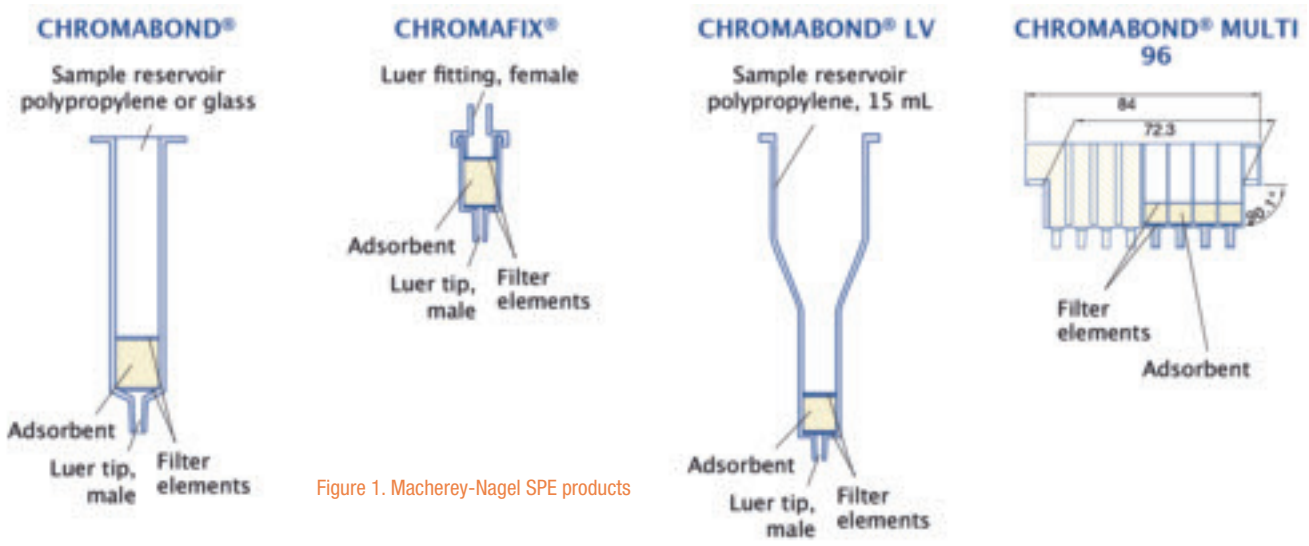


Figure 1. Macherey-Nagel SPE products

CHROMABOND EASY

CHROMABOND EASY is a polystyrene-divinylbenzene copolymer, polar bifunctionally modified with a weak ion-exchanger. It is suitable for a broad range of compounds. Little or no preconditioning and equilibration is required prior to loading aqueous samples. CHROMABOND EASY offers a higher binding capacity than silica based sorbents and is stable over the pH range 1 to 14. Typical applications include drug screening of samples from urine, blood, serum and plasma, compounds from tablets and creams, polar herbicides/pesticides from water, polar phenols from water, polyaromatic compounds and PCBs.

CHROMABOND Silica Based Phases

The bonded silica phases are stable in the pH range 2 – 8 and are stable in almost all organic solvents. They show no swelling or shrinking and have a mean pore size of 60Å, allowing adsorption of compounds up to a molecular weight of 5000 Da. Please see page 304 for ordering information on a selection of the more popular silica phases.

CHROMABOND Speciality Phases

A selection of the more specialised CHROMABOND phases is listed below. Please contact Hichrom for ordering information.

Phase	Application
ABC18	Extraction of acrylamide from ultra-heated starch-containing food
Drug	Enrichment of acidic, neutral and basic drugs from urine or plasma
Drug II	Extraction of THC and derivatives from urine, blood, serum, plasma
Crosslinks	Collagen crosslinks in urine
NAN	Extraction of PCBs from sludge
C18 PAH	PAHs from water
Na_2SO_4/Florisil	Hydrocarbons from drinking, surface and waste waters
CN/SiOH	Extraction of the 16 PAHs according to EPA from soil samples
SiOH-H^+/SA	Extraction of PCBs from oil
Diamino	QuEChERS method for pesticide extraction – please enquire for further details

Please contact Hichrom for a copy of the Macherey-Nagel Solid Phase Extraction Application Guide

CHROMABOND XTR

CHROMABOND XTR is based on coarse-grained kieselguhr (also known as diatomaceous earth), consisting of naturally occurring amorphous silicic acid. It can be used in the pH range 1 – 13 and has a large pore size with a high pore volume. It is a fast, reproducible and economical alternative to liquid-liquid extraction. CHROMABOND XTR is especially useful for highly viscous aqueous solutions, such as blood, plasma or serum. Columns with volumes of 1ml to 150ml and adsorbent weights of 250mg to 37.5g are available. Please enquire for further details and ordering information.

Custom Packed SPE Columns

CHROMABOND special SPE columns can be prepared according to customer's specifications of volume and adsorbent weight. Combination and mixed phase SPE cartridges can also be prepared. Please contact Hichrom for further details.

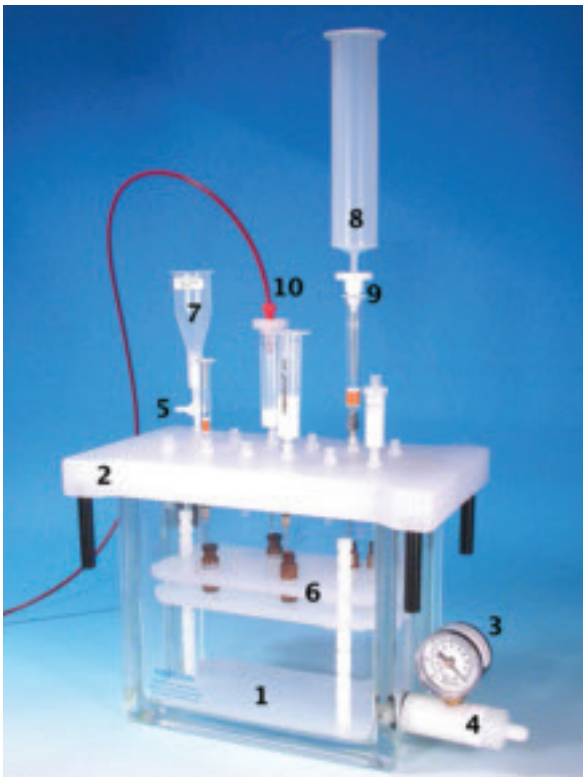
CHROMABOND® Solid Phase Extraction Products (continued)

Vacuum Manifold Assembly

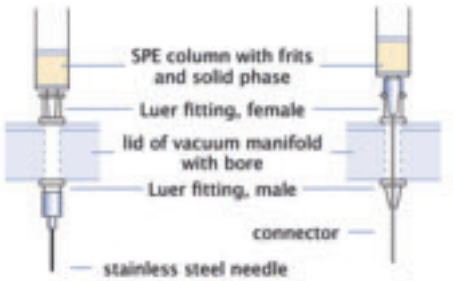
- For simultaneous preparation of up to 12, 16 or 24 samples
- Replacement parts and accessories for special applications

Vacuum Manifold Components

The figure below shows the individual components of a complete vacuum manifold for 12 CHROMABOND® columns or CHROMAFIX® cartridges.



1. Rectangular glass cabinet (larger size cabinet suitable for up to 16 CHROMABOND LV columns or up to 24 CHROMABOND columns or CHROMAFIX cartridges also available)
2. Polypropylene lid
3. Vacuum gauge for pressure reading
4. Control valve for adjustment of vacuum
5. Replaceable valves for vacuum control of individual SPE columns
6. Variable rack with exchangeable partitions, which accept a wide variety of vessels like test tubes, measuring flasks, scintillation vials, autosampler vials, plastic vials etc.
7. CHROMABOND LV columns with 15ml sample reservoir for medium size samples
8. Polypropylene sample reservoirs (30 or 70ml)
9. Adapter for sample reservoirs
10. CHROMABOND tubing adapters



Protection from cross contamination

For special applications which require maximum protection from cross contamination, chrome-plated brass valves and stainless steel or PTFE connectors can be supplied. As these connectors are fitted through the lid, the sample only has contact with the inert connector and can flow directly into the receptacle. Please enquire for further details.

Ordering Information

	12-port	16-port[1]	24-port
Vacuum Manifold Assembly	730150	730360	730151

[1] For LV columns

CHROMABOND replacement parts and accessories including drying attachments, collecting racks and tubing adapters are also available – please contact Hichrom for details.

CHROMABOND Empty Columns and Accessories

- For individual packing of SPE columns with CHROMABOND adsorbents

A range of empty polypropylene columns with PE frits is available for customers wishing to pack their own SPE columns. Adapters for polypropylene columns, empty glass columns and frits and empty LV polypropylene columns with PE frits can also be supplied.

Ordering Information - CHROMABOND® SPE Products

CHROMABOND HR-X*pert* Series (Polypropylene Columns[1])

CHROMABOND Phase (85µm)[2]	Sorbent Mass/Volume Capacity						
	30mg/1ml	60mg/3ml	100mg/1ml	150mg/6ml	200mg/3ml	500mg/3ml	500mg/6ml
Pack Size	**30**	**30**	**30**	**30**	**30**	**30**	**30**
HR-X[3]	730934	730936	730935	-	730931	730937	730939
HR-XC	730969	730956	730049	730957	730952	730953	730955
HR-XA	730968	730950	730727	730958	730951	730954	730966
HR-XCW	730731	730735	730733	730737	730739	730741	730743
HR-XAW	730728	730747	730729	730749	730748	730744	730745

[1] CHROMAFIX cartridges and loose sorbent also available [2] 45µm phases also available – please enquire [3] Other adsorbent mass/volume columns available

CHROMABOND Silica and Other Phases (Polypropylene Columns[1, 2])

CHROMABOND Phase[3]	Sorbent Mass/Volume Capacity[4]				
	100mg/1ml	200mg/3ml	500mg/3ml	500mg/6ml	1000mg/6ml
Pack Size	**100**	**50**	**50**	**30**	**30**
C18 ec	730011	730012	730013	730014	730015
C18	730001	730002	730003	730004	730005
C18 Hydra	730295	730296	730297	730299	730300
C8	730021	730022	730023	730024	730134
C4	730225	-	730227	-	-
C2	730169	-	730221	730409	730410
C_6H_{11} ec	-	-	730442	730443	730444
C_6H_5	730083	730411	730084	-	-
NH2	730031	730413	730033	730180	730626
CN	730061	730420	730063	730421	-
OH	730051	730417	730053	730418	-
SiOH	730071	730214	730073	730070	730075
PCA	-	-	730482	730483	730484
PSA	730460	-	730462	-	730464
SA	730076	730275	730077	730425	730212
SB	730078	730322	730079	730426	730323
EASY	730752[5]	730754[5]	730759[5]	730756	-
HR-P	730280[5]	730108[5]	730117[5]	730111	730118
PS-RP	-	730765[5]	730692[5]	730693[5]	-
Alox A	-	-	730452	730453	730017
Alox N	-	-	730446	730447	730139
Alox B	-	-	730429	730466	730020
Florisil	-	730457	730081	730238	730082

[1] Glass columns also available for some phases
[2] CHROMAFIX cartridges and CHROMABOND MULTI 96-well plates also available
[3] Other phases available
[4] Other adsorbent mass/volume columns available
[5] 30/pack

Empty Polypropylene Columns with PE Frits[1]

Volume	1ml	3ml	6ml	15ml	30ml	45ml	70ml	150ml
Pack Size	**100**	**50**	**30**	**20**	**20**	**20**	**20**	**20**
	730159	730160	730161	730230	730380	730355	730158	730474

[1] One filter element already inserted in polypropylene column

PE Frits for Polypropylene Columns

Column Volume	1ml	3ml	6ml	15ml	30ml	45ml	70ml	150ml
Pack Size	**250**	**250**	**250**	**250**	**250**	**250**	**250**	**250**
	730164	730162	730163	730351	730034	730356	730026	730475

THERMO SCIENTIFIC SOLID PHASE EXTRACTION PRODUCTS

Thermo Scientific manufacture a wide range of SPE products for sample preparation, in both column and 96 well plate formats. The wide range of phases is suitable for use in application areas such as pharmaceutical, biochemical, environmental and food and beverage. The polypropylene columns are chemically resistant and are available in a range of bed weights. Samples can be processed through the columns by vacuum, by positive pressure or by centrifugation. Thermo Scientific offer two main SPE ranges, SOLA™ (innovative fritless SPE products) and HyperSep™.

SOLA™

- First fritless SPE product
- Higher reproducibility
- Higher extract cleanliness
- Increased sensitivity
- Reduced solvent requirements

Thermo Scientific have introduced SOLA, the first fritless SPE product range. SOLA provides greater reproducibility with cleaner, more consistent extracts. The proprietary manufacturing process involved in the production of SOLA products eliminates issues that can be associated with conventional loose-packed SPE products.

Conventional SPE cartridges and well plates are packed with loose silica or polymeric material positioned between two frits. These packed beds are potentially prone to settling and voiding in production or transportation, thus creating phase channelling and packing irreproducibility. SOLA fritless SPE products have been designed to overcome these potential inconsistencies by combining the polyethylene frit material and the media components into a uniform sorbent bed, removing the need for frits.

The manufacturing process has the additional benefit of removing extractables from component parts, resulting in cleaner sample extracts. SOLA products provide reduced failure rates, higher analysis speeds and lower solvent requirements.

SOLA products are available in 10mg/1ml cartridge and 10mg/2ml 96 well plate formats.

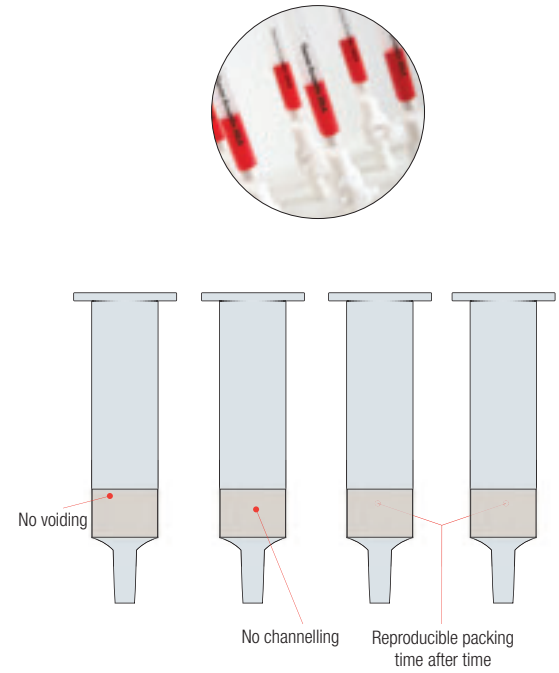


Figure 2. SOLA eliminates common issues associated with conventional SPE

Ordering Information - SOLA SPE Cartridges[1]

Description	Bed Weight (mg)	Column Volume (ml)	Cat. No.	Quantity	Price
SOLA HRP	10	1	60109-001	100	
SOLA SCX	10	1	60109-002	100	
SOLA SAX	10	1	60109-003	100	

[1] New WCX and WAX phases also available – please enquire

Ordering Information - SOLA 96 Well Plates[1]

Description	Bed Weight (mg)	Volume (ml)	Cat. No.	Quantity	Price
SOLA HRP	10	2	60309-001	1	
SOLA SCX	10	2	60309-002	1	
SOLA SAX	10	2	60309-003	1	

[1] New WCX and WAX phases also available – please enquire

HyperSep™ Solid Phase Extraction Products

Thermo Scientific's HyperSep SPE products are available in both SPE column and 96 well plate formats and a wide range of phases for all applications.

HyperSep Retain

- Exceptional recoveries for polar and non-polar analytes
- High and consistent recoveries
- pH stable 0 to 14

The HyperSep Retain range is based on a high purity, highly porous polystyrene-divinylbenzene polymer. In the Retain PEP product (**P**olar **E**nhanced **P**olymer), this polymer is modified with urea functional groups to give balanced retention of both polar and non-polar analytes. The polymeric adsorbent does not dry out after conditioning, enabling consistent recovery levels to be achieved. It is ideal for the retention of drugs and metabolites from biological fluids.

HyperSep Retain-CX and Retain-AX are high capacity materials, where the polymer is partially modified with sulphonic acid or quaternary ammonium groups, respectively. They are suitable for the analysis of a wide range of drugs of abuse and their metabolites.

HyperSep™ Solid Phase Extraction Products (continued)

HyperSep Servo+™ and HyperSep Servo™

HyperSep Servo+™ and HyperSep Servo™ cartridges and 96 well plates provide optimised SPE solutions for the analysis of drugs of abuse. They offer high levels of reproducibility and cleanliness of extract for dealing with difficult to analyse biological sample matrices. Servo+ cartridges and plates provide the additional benefit of greater selectivity, higher loading capacities and improved robustness. Both HyperSep Servo+ and HyperSep Servo ranges offer optimised solutions for different compound classes.

Phase	Application
Total	Screening of a wide range of unknown components
Total A	Screening of a wide range of unknown acidic compounds
Total B	Screening of a wide range of unknown basic compounds
THC	For dedicated extraction of THC and associated metabolites
Opiates	For dedicated extraction of opiate class compounds
AMP	For dedicated extraction of amphetamine class compounds
PCP	For dedicated extraction of PCP (phenylcyclidine) class compounds
Cocaine	For dedicated extraction of cocaine class compounds

Please contact Hichrom for ordering information for HyperSep Servo+ and HyperSep Servo SPE products.

HyperSep Hypercarb

HyperSep Hypercarb, based on 100% porous graphitic carbon, can retain highly polar compounds through a dipole-dipole type of interaction. The high capacity factor of Hypercarb for polar analytes allows large volumes of water samples to be handled, without breakthrough.

HyperSep Silica Sorbents

A range of trifunctional bonded silica phases (C18, C8, Phenyl, Aminopropyl, Cyano, Diol, SAX, SCX) and unbonded silica are available in SPE column format, in addition to 96 well plates and individual plates.

HyperSep Verify-CX and -AX

The Verify SPE products are mixed mode sorbents based on two functional groups – C8 and an ion-exchanger (benzenesulphonic acid for Verify-CX and a quaternary amine for Verify-AX). Verify-CX is copolymerised on a rigid, purified silica support and is suitable for the extraction of basic drugs from biological matrices. Verify-AX is a rigid silica support to which the two functionalities are copolymerised. It is suitable for the extraction of acidic drugs such as THC.

QuEChERS Dispersive SPE Products

- Determine greater number of pesticides than with standard SPE
- Easy to use
- Available in a number of configurations

The QuEChERS (**Qu**ick, **E**asy, **Ch**eap, **E**ffective, **R**ugged and **S**afe) method is gaining popularity for multi-residue pesticide analysis in food and agricultural products. The method is a two-step process involving extraction followed by clean-up.

The extraction step products use $MgSO_4$ to reduce water in the sample along with either NaCl or anhydrous sodium acetate (for use with base-sensitive compounds). These products are supplied in 50ml polypropylene centrifuge tubes. For the clean-up step, different sorbent combinations are available dependent upon the application. PSA (primary/secondary amine) removes polar organic acids, pigments and sugars. Some products couple the PSA with endcapped C18 for the removal of most lipids and sterols, or graphitised carbon for the removal of sterols and pigments such as chlorophyll.

Product Selection

Matrix Type	Examples	Sorbent Requirements
General matrices	Apples, cucumber, melon	$MgSO_4$, PSA
Fatty matrices	Milk, cereals, fish	$MgSO_4$, PSA, C18
Pigmented matrices	Lettuce, carrots, wine	$MgSO_4$, PSA, C18, graphitised carbon black
Highly pigmented matrices	Spinach, red peppers	$MgSO_4$, PSA, C18, graphitised carbon black

Ordering Information

HyperSep™ Polypropylene Columns[1]

Phase	Sorbent Mass/Volume Capacity[2]					
	50mg/1ml	100mg/1ml	200mg/3ml	500mg/3ml	500mg/6ml	1000mg/6ml
Pack Size	**50**	**30**	**30**	**-**	**20**	**10**
Hypercarb	60106-303	60106-302	60106-301	-	60106-402	60106-403
Pack Size	**100**	**100**	**50**	**50**	**30**	**30**
C18	60108-390	60108-302	60108-303	60108-304	60108-305	60108-301
C8	60108-391	60108-392	60108-393	60108-309	60108-394	60108-427
Phenyl	60108-516	60108-386	60108-387	60108-388	60108-389	60108-517
Silica	60108-409	60108-317	60108-410	60108-315	60108-411	60108-426
SAX	60108-417	60108-418	60108-419	60108-521	60108-360	60108-434
SCX	60108-420	60108-421	60108-422	60108-423	60108-520	60108-433
Aminopropyl	60108-424	60108-364	60108-425	60108-518	60108-519	60108-432
Cyano	60108-746	60108-745	60108-747	60108-748	60108-749	60108-750
Diol	60108-571	60108-572	60108-573	60108-574	60108-575	60108-576
Florisil	60108-402	60108-403	60108-404	60108-405	60108-500	60108-431

[1] 96 well plates and individual wells also available – please enquire [2] Other adsorbent mass/volume columns available

Phase	Sorbent Mass/Volume Capacity					
	30mg/1ml	30mg/3ml	60mg/3ml	200mg/3ml	500mg/3ml	500mg/6ml
Pack Size	**100**	**50**	**50**	**50**	**50**	**30**
Retain PEP	60107-201	60107-202	60107-203	60107-204	60107-205	60107-206
Retain-CX	60107-301	60107-302	60107-303	60107-304	60107-305	60107-306
Retain-AX	60107-401	60107-402	60107-403	60107-404	60107-405	60107-406

Phase	Sorbent Mass/Volume Capacity					
	130mg/1ml	300mg/3ml	500mg/3ml	200mg/6ml	500mg/6ml	1000mg/6ml
Pack Size	**100**	**50**	**50**	**50**	**30**	**30**
Verify-CX	60108-719	60108-720	60108-721	60108-722	60108-723	60108-724
Verify-AX	60108-727	60108-728	60108-729	60108-730	60108-731	60108-732

A comprehensive range of SPE accessories is also available – please enquire.

QuEChERS Dispersive SPE Extraction Products

Description	Format	Quantity	Catalogue No.	Price
6g Anhydrous $MgSO_4$, 1.5g anhydrous sodium acetate	50ml polypropylene centrifuge tubes	250	60105-210	
4g Anhydrous $MgSO_4$, 1g NaCl	50ml polypropylene centrifuge tubes	250	60105-211	

QuEChERS Dispersive SPE Clean-Up Products

Description	Format	Quantity	Catalogue No.	Price
150mg Anhydrous $MgSO_4$, 50mg PSA and 50mg carbon	2ml micro-centrifuge tubes	100	60105-202	
150mg Anhydrous $MgSO_4$, 50mg PSA	2ml micro-centrifuge tubes	100	60105-203	
150mg Anhydrous $MgSO_4$, 50mg PSA and 50mg endcapped C18	2ml micro-centrifuge tubes	100	60105-204	
900mg Anhydrous $MgSO_4$, 300mg PSA and 150mg carbon	15ml centrifuge tubes	50	60105-205	
900mg Anhydrous $MgSO_4$, 300mg PSA and 150mg endcapped C18	15ml centrifuge tubes	50	60105-206	
400mg PSA on bottom, 200mg graphitized carbon on top, separated by a Teflon frit	6ml columns	30	60105-207	
500mg PSA on bottom, 250mg graphitized carbon on top, separated by a Teflon frit	6ml columns	30	60105-208	
500mg PSA on bottom, 500mg graphitized carbon on top, separated by a Teflon frit	6ml columns	30	60105-209	