



## Sometimes Different **IS** Better

The Opus™ product line represents state of the art pre-packed column technology. The Opus commitment to the Open Platform User Specified combined with the flexibility of the patented column design means that virtually any resin is available in flexibly customizable bed heights. This makes the Opus platform broadly applicable to most chromatography process steps, for most therapeutics across all scales.

Opus™ pre-packed columns are designed for the purification of biopharmaceuticals. Opus is equally suited to process development as well as clinical and smaller scale commercial manufacturing. They can be used in any chromatographic application, with virtually any commercially available resin.

In order to be truly relevant pre-packed columns need to demonstrate:

- Broad applicability to many processes, for a range of different therapeutics
- Broad applicability to different manufacturing strategies
- Ability to perform to the highest levels expected by the industry

## Broad Applicability to Many Processes:

Thanks to its basic design Opus is a completely flexible system which is supported by Repligen's commitment to an "Open Platform". This means columns can be packed at a customer specified bed height and column diameter (See details on currently available product range). Opus can function effectively with most process resins and a range of bed heights.

The inherent flexibility of Opus offers broad applicability beyond just monoclonal antibody purification. Opus can be applied with equal effectiveness in chromatography steps wherever pre-packed or single use columns will provide efficiency or economic benefits. From vaccines to viral vectors, gene therapy to recombinant proteins and beyond.

## Broad Applicability to Different Manufacturing Strategies:

Opus is the answer for different manufacturing strategies whether it is the convenience of pre-packed columns, or a commitment to single use disposable manufacturing technologies. Careful column design combined with automated packing means that Opus pre-packed columns are not only easy and efficient to use but they also ensure packing performance that will meet or exceed that of hand packing.

For Single Use manufacturing Opus pre-packed column technology offers disposability at a very attractive cost. Combining Opus columns with lower upfront investment, limited cycle resins makes for a compelling single use value proposition.

## Open Platform

Most chromatographic purification processes involve multiple chromatography steps using different resins. Opus offer the convenience of providing a broad range of commercially available resins at customizable bed heights. Ask about Repligen's custom packing service.

## Opus™ Pre-packed Column Features and Benefits

Opus columns are run ready, easy to use and offer a single solution for pre-packed resins of all types. They can remove or reduce many onerous process steps and practices like cleaning, cleaning validation, sanitization and storage. Opus columns can also be supplied ready sanitized. They can be cleaned and reused or discarded after single use. They offer the flexibility required during PD and clinical scale up with the performance expected for commercial manufacturing – All with an economically justifiable investment.



### Feature

Prepacked columns

### Benefit

- Time saving
- Reproducible packing performance
- Reliable option for difficult to pack resins
- No column assembly, cleaning or repair

### Feature

Open Platform

### Benefit

- Most commercially available resins
- Not restricted to one vendor's resin
- Can be applied to all steps in a process

### Feature

Automated Column Packing

### Benefit

- Customizable bed height
- Tuneable resin packing parameters
- Excellent packing performance
- Excellent packing reproducibility
- Excellent bed stability

### Feature

Stainless steel swage closure

### Benefit

- Robust, easy to handle
- Supports medium pressure applications
- Supports smaller particle resins

### Feature

Cost effective single or campaign use

### Benefit

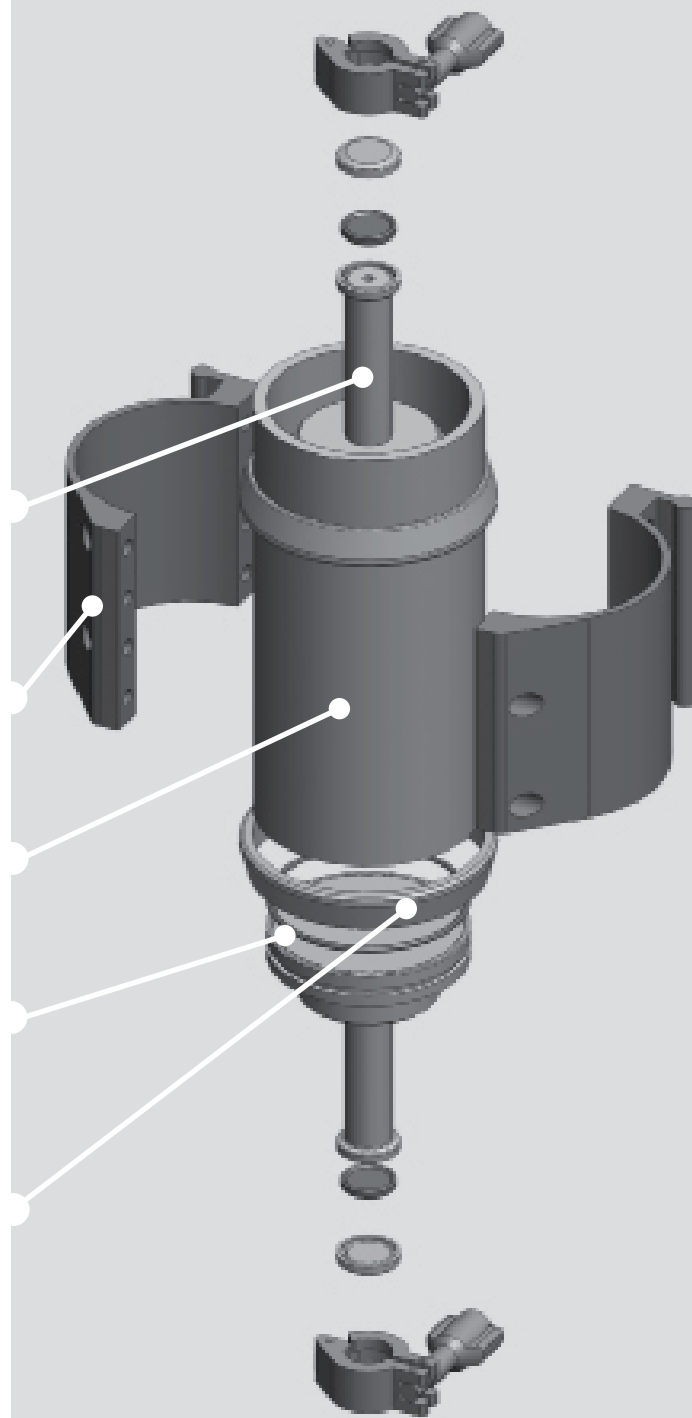
- No cross contamination problems
- Reduced validation buffer & CIP requirements

## Opus™ Column Design and Construction

Opus columns have been designed according to applicable “best principles” of accepted column design to ensure the highest levels of performance.

## Opus™ Column Elements of Construction

- **Top Cap Assembly:** Made of nylon, with a nylon screen and EPDM O-ring. This ultrasonically welded assembly is made of plastics chosen for performance as well as their biological and chemical compatibility.
- **Outer Column Housing:** A non-fluid contact part is made of powder coated aluminum, and acts as a pressure support shell. This is optional for 80mm diameter columns.
- **Column Body:** Is an extruded polyethylene tube that undergoes secondary internal preparation to ensure complete roundness for easy cleaning as well as enhanced packing and flow properties.
- **Bottom Cap Assembly:** Made of nylon, with a nylon screen and EPDM O-ring. This thermal welded assembly is made of plastics chosen for performance as well as their biological and chemical compatibility.
- **Swage Ring:** A non-fluid contact, 316 stainless steel, swage rings the column tube tight to the end caps. This seals the cap to the internal tube surface removing the O-ring from the fluid contact path.



Note: Fluid contact materials

- Meet the USP (United States Pharmacopeia) class VI requirements according to USP<88> Reactivity Tests, “In Vivo and FDA CFR 177.
- Are “Animal Free” or have been manufactured in compliance with EMEA/410/01

During manufacturing the bottom cap is swaged to the column body, the slurry is flow packed and automatically compressed to a predetermined specification appropriate for each different resin. The columns are then performance tested in situ prior to swaging the top cap and finishing the column. Once complete the finished columns are tested again for plate count asymmetry and flow delta p to ensure that specifications are met.

### Automated Column Packing:

The column packing process is central to ensuring both excellent AND reproducible column performance.

**Packing Studies:** Chromatography resins comprise very different base materials; from very soft SEC gels through the more commonly used agarose to more rigid polymeric and ceramic type beads. Different densities and particle sizes compound the complexity. Although individual resin vendors provide packing instructions the processes often need to be optimized.

As a part of the Opus “Open Platform User Specified Program”. Repligen will conduct and document a packing study optimizing the packing of individual resins into the Opus™ platform. The flexibility of the Opus packing system enables many critical factors to be manipulated, thus fully optimizing the packing process. This ensures excellent packing performance, a requirement with many of the recognized “hard to pack resins”.

### The column packing process is automated and occurs in 3 phases:

phase  
1

**Slurry Flow Packing:** The resin to be packed is prepared according to the manufacturers recommendations. It is then packed into the Opus column body as a metered charge based on the % solids or time and flow monitoring. This ensures a consistent resin charge, bed height and compression pressure.

phase  
2

**Bed Compression:** Once the flow packing is complete the top cap assembly is mounted into the column body and pressed into place using an automated skid which applies the exact amount of packing pressure. The result is a stable and consistent packed bed.

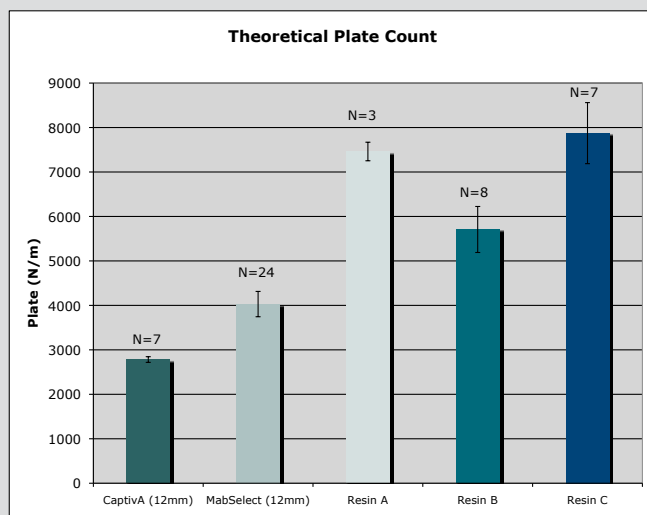
phase  
3

**Bed Testing:** Each individual column is tested for asymmetry, theoretical plate count and flow delta p to ensure reliable and consistent performance.

## Opus™ Prepacked Column Performance

The combination of optimization studies and automated packing ensures that prepacked Opus run ready columns are applicable to a wide range of resins. Packing performance, is typically reported in terms of theoretical plate count and peak asymmetry which varies with both resin type and test method. Figure & table 1. shows the utility and capability of the Opus platform to achieve highly reproducible packing performance across different resin types as demonstrated by a measurement of plate count. In all cases peak asymmetry was within established limits. In the case of the two different agarose based Protein A resins the combined data set of peak asymmetry measurements were consistently between 0.8 and 1.2.

figure  
1



Column packing control and consistency as demonstrated by theoretical plate count (HETP) measurements

Resin Type	CaptivA PriMAB	MabSelect	Resin A	Resin B	Resin C
Column Ømm	12	12	80	80	80
Mean	2782	4029	7461	5707	7874
Stdev	64	285	209	518	687
%CV	2.3	7.1	2.8	9.1	8.7

Notes:  
Resin A: A small particle cation IEX  
Resin B: A large particle cation IEX  
Resin C: An agarose based HIC media

## Pre-Packed Column Performance – Consistency and Stability

The chromatograms in Figures 2, and 3 demonstrate the consistency and stability of the Opus prepacked column platform.

Figure 2 demonstrates the reproducibility of column packing. Five individual columns were packed as noted and chromatographic consistency was evaluated. Each column was cycled 3 times for a total of 15 runs. The figure is an overlay of all 15 run results. There is clearly no separation of the 15 chromatograms indicating that the chromatographic output was essentially identical with an average yield of >97% and a 2.5% variance. This clearly demonstrates that Opus pre-packed columns

provide the highest level of robustness and reproducible performance required for critical purification processes.

Packed Bed Stability – is also demonstrated in Figure 2, where 2 of the 15 runs were conducted on a column which had been aggressively shaken by placing the column on an orbital shaker at 200rpm for 30mins in an unprotected box, a pre treatment designed to simulate ‘dropping’ and transportation. The 2 runs conducted on this column are indistinguishable from the runs conducted with the more carefully handled columns.

figure

2

### Column Packing Reproducibility and Stability

**Dimensions:**

12mm diameter by  
 100mm bed height

**Packing:**

CaptivA™ PriMAB  
 Protein A Resin

**Mobile Phase**

Phosphate Buffered Saline  
 100mM Glycine pH 3.0

**Sample**

Polyclonal Human  
 Immunoglobulin

**FPLC:**

AKTA Explorer 100

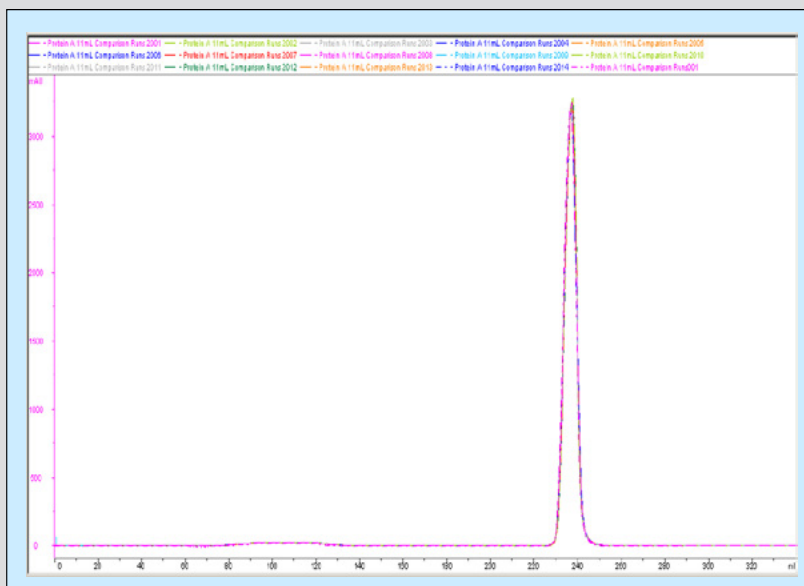
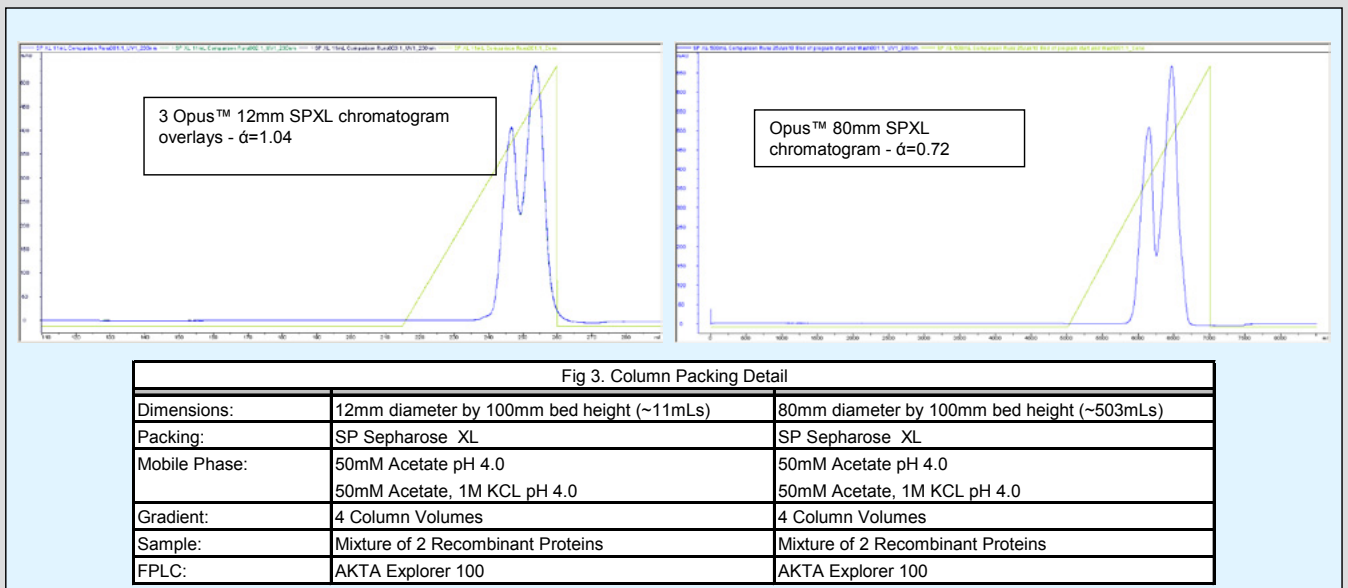


Figure 3 demonstrates the scalability of chromatographic performance from the Opus 12 to Opus 80 pre-packed platforms. The columns were packed with an Ion Exchange resin as noted and their chromatographic performance compared. Each column was loaded with comparable levels of two different recombinant proteins and the chromatographic method was scaled identically for each column. The 12mm Opus column was cycled 3 times, with the chromatographic output being practically identical, providing a resolution factor of 0.72 for the un-optimized protein separation. Using the same process conditions the Opus 80 column provided a resolution factor of 1.04 demonstrating the scalability of the Opus platform.

figure  
**3**



# OPUS™ Open Platform Pre-packed Columns

## Ordering and Product Range

Opus™ pre-packed columns are designed for flexibility such that the columns can be custom made for both diameter and bed height. The current column platform is anticipated to cover a range of diameters from 1.2 to 20cm and any bed height between 3 and 20cm. The following table describes the current range and availability. Each column is a custom combination of resin, bed height and column diameter. Please call Repligen to discuss your specific needs.

**Call today:**  
**781 250-0111**

## Contact details:

Repligen Bioprocessing  
41 Seyon Street  
Waltham MA, 02453  
Tel: 781 250-0111  
bioprocessing@repligen.com  
www.repligen.com/bioprocessing

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## Opus™ Custom: Open Platform User Specified Product Range

Column Diameter cm	Bed Height cm Increments	Bed Volume mLs	Availability
1.2	Min	3	~3 Available
	Max	20	~23 Available
2.5	Min	3	~15 Available
	Max	20	~98 Available
5.0	Min	3	~59 Development Inquire
	Max	20	~393 Development Inquire
8.0	Min	3	~150 Available
	Max	20	~1005 Available
20.0	Min	3	~943 Development Inquire
	Max	20	~6284 Development Inquire

## Opus™ Standard: CaptivA rProtein A Pre-packed Resin Product Range

Cat Number	Resin/Volume	Column Style/Size	Bed Height
BS-012-CPRI-010	CaptivA™ PriMAB ~11mLs	Opus 12mm Ø	10cm
BS-012-CPRI-020	CaptivA™ PriMAB ~23mLs	Opus 12mm Ø	20cm
BS-025-CPRI-010	CaptivA™ PriMAB ~49mLs	Opus 25mm Ø	10cm
BS-025-CPRI-020	CaptivA™ PriMAB ~98mLs	Opus 25mm Ø	20cm
BS-050-CPRI-010	CaptivA™ PriMAB ~196mLs	Opus 50mm Ø	10cm
BS-050-CPRI-020	CaptivA™ PriMAB ~393mLs	Opus 50mm Ø	20cm
BS-080-CPRI-010	CaptivA™ PriMAB ~503mLs	Opus 80mm Ø	10cm
BS-080-CPRI-020	CaptivA™ PriMAB ~1005mLs	Opus 80mm Ø	20cm
BS-200-CPRI-010	CaptivA™ PriMAB ~3142mLs	Opus 200mm Ø	10cm
BS-200-CPRI-020	CaptivA™ PriMAB ~6284mLs	Opus 200mm Ø	20cm

## Opus™ Column Specifications

Opus Column Specifications	
Components	Unitary endcaps - Nylon 66 Column body - Extruded Polypropylene Flow screens & frits - Nylon 66 12mm Frits - Titanium O-rings - EPDM (non-fluid contact)
Connections	12mm - 10-32 UNF 1/16 in fittings 80mm - 3/4 in. fractional triclover
Maximum pressure rating	12mm up to 10bar 80mm up to 10 bar with appropriate optional housing
Chemical Compatibility‡	Good for most typical chromatographic buffers & solvents including: Aqueous buffers and salt solutions 8M Urea 6M Guanidine 4M NaOH 25% Ethanol 20% Acetone
Temperature Range	4 - 30 °C

Notes: Broad chemical compatibility applies as the exposure is either for longer exposures in aqueous buffers OR typically used organic solvents at low concentration for short exposure times.