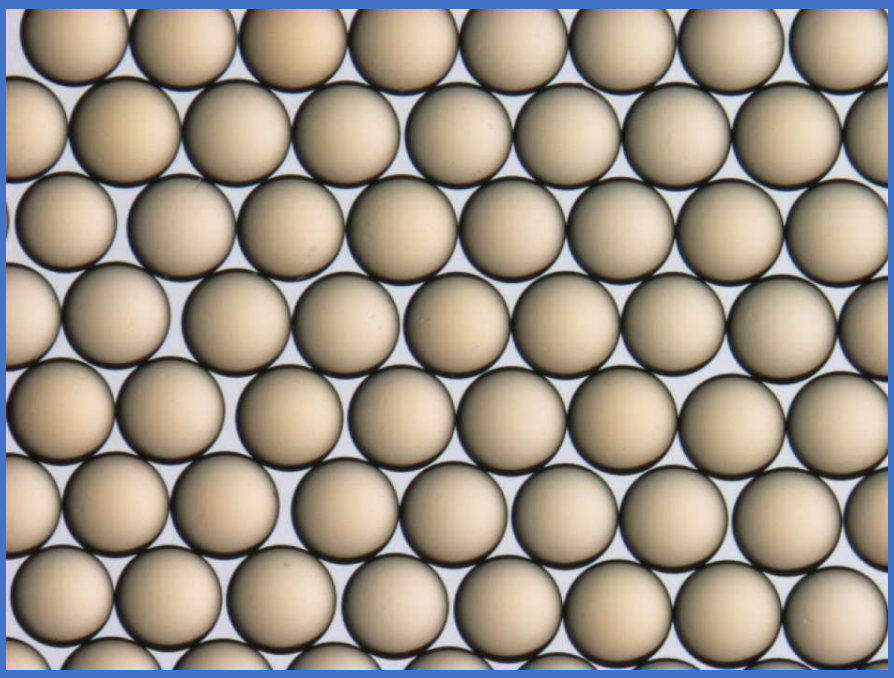
Rev.1

MITSUBISHI CHEMICAL

DIAION™ Technical Guide

Ion Exchange Resin for Sugar Chromatography



[Chromatography in sugar separation]

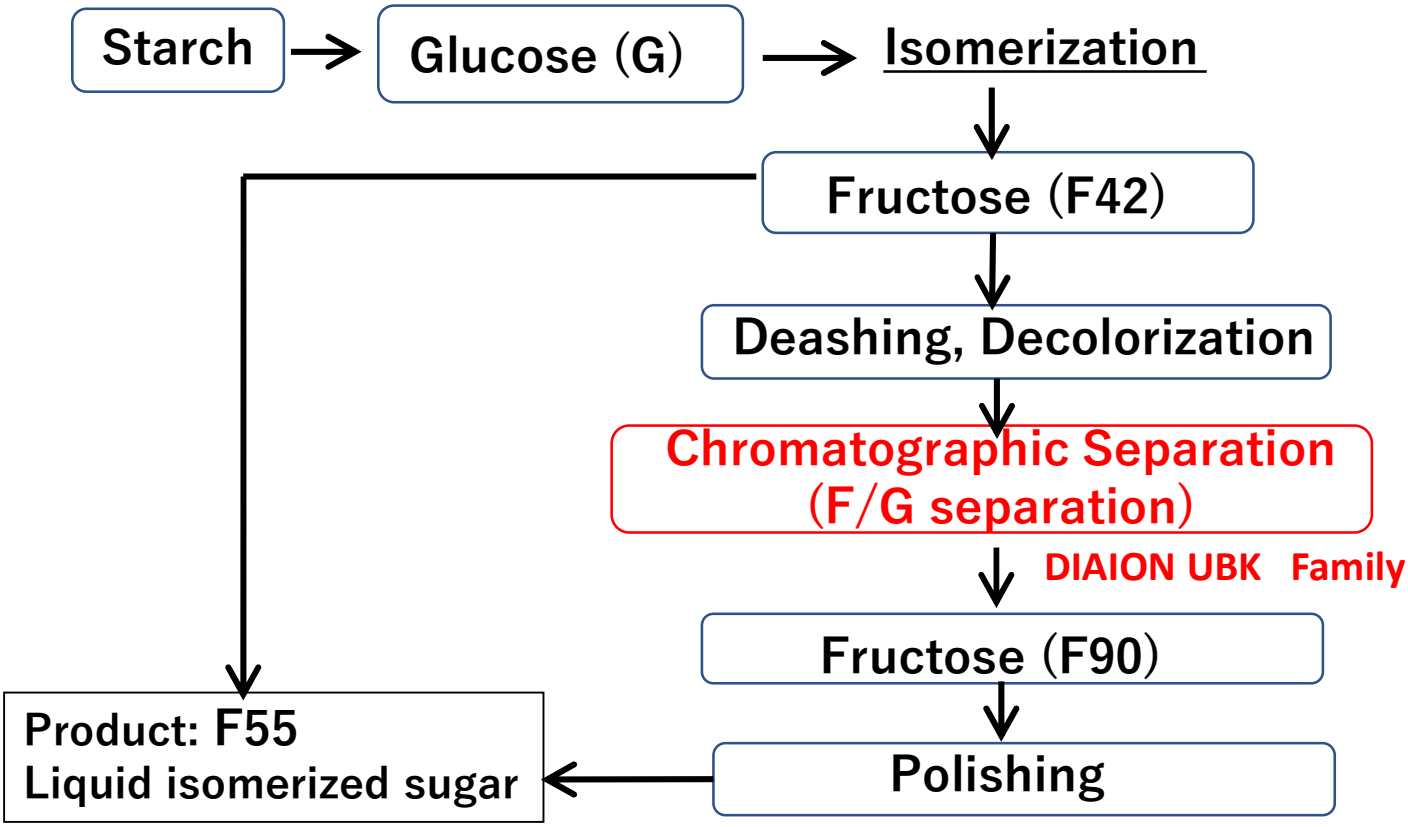
For separation of sugars with similar structures and also oligosaccharides with different degrees of polymerization, industrial chromatographic separation is often used.
Typical examples of the chromatographic separation process are shown below.

○Recovery of sucrose from molasses
○Separation of glucose and fructose
○Separation of oligosaccharides (trehalose, maltose, malto-oligosaccharide, fructo-oligosaccharide, etc.)
○Separation of sugar alcohols (maltitol, mannitol, erythritol, xylitol, sorbitol)
○Separation of indigestible dextrin, rare sugar (allulose, etc.), inulin (natural polysaccharide)

For such separation, a continuous chromatographic separation equipment such as a simulated moving bed system is used, because the production efficiency is low in a single-column type (batch type) chromatographic separation.

[Example of chromatographic separation process]

The fructose / glucose chromatographic separation process is introduced below.
High fructose corn syrup, which is often used in soft drinks, is produced by converting glucose into fructose using an enzyme, but the purity of fructose is, as it is, only about 42% (F42).
Fructose purity should be increased to 55% (F55) to achieve the same sweetness as sucrose.
An overview of this process is shown below.



The manufacturing process of F55 is composed by the following steps:
-enzymatically decomposing the raw material starch to obtain glucose
- isomerizing glucose, followed by purifying and concentrating the solution to obtain F42
-deashing & decolorizing F42 and chromatographic separation of F/G mixture to obtain F90
-mixing F90 with F42 to obtain F55

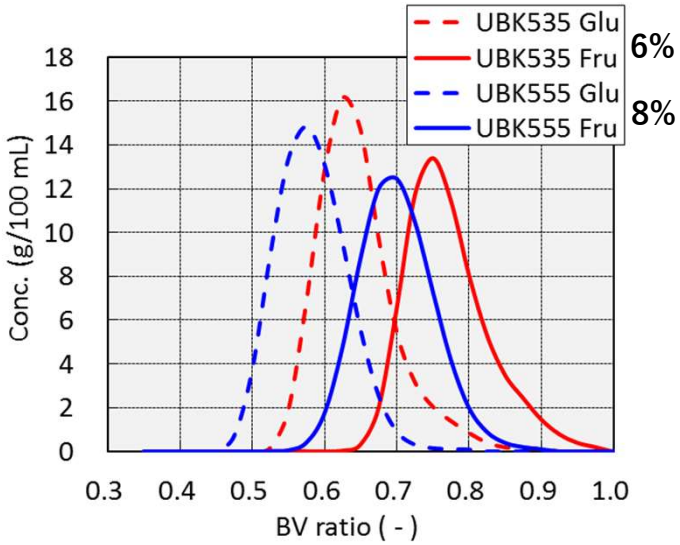
DIAION UBK grades, uniform particle size ion exchange resins, have been used worldwide for over 40 years in the most important chromatographic separation process in this process.

[Effect of cross-linkage % and particle size of UBK on separation performance]

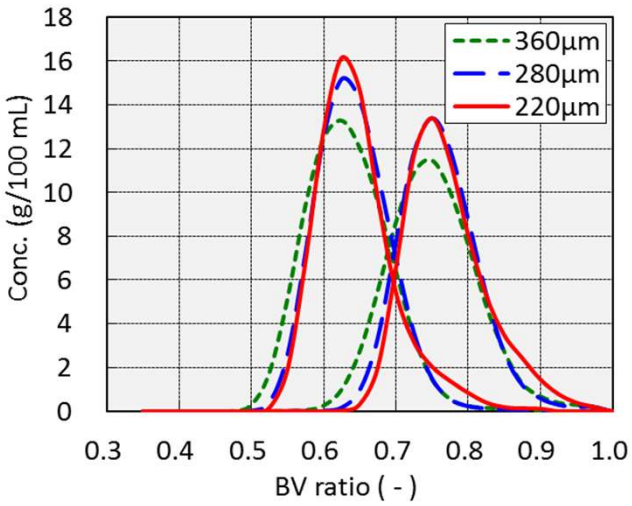
- Example of F / G separation -

The figure below shows the effects of the cross-linkage% and particle size of UBK, which is a uniform particle size resin, on fructose / glucose (F / G) separation performance. Regarding the separation performance, the lower the cross-linkage%, the higher (6%> 8%), and the smaller the particle size, the higher (220> 280> 360 μm).

Effect of cross-linkage% (particle size: 220 μm)



Effect of particle size (cross-linkage%: 6%)



UBK Family, which is a uniform particle size resin, has many grades depending on the targets and conditions of chromatographic separation. Ca-form , K-form, and Na-form UBK are often used for chromatographic separation of isomerized sugar, chromatographic purification of beet sugar, and chromatographic removal of lactose, respectively.

In addition, various grades are available from the viewpoint of the chromatographic separation performance and system operating. The table below shows typical examples of UBK grades with different cross- linkage%, particle size, and ionic form.

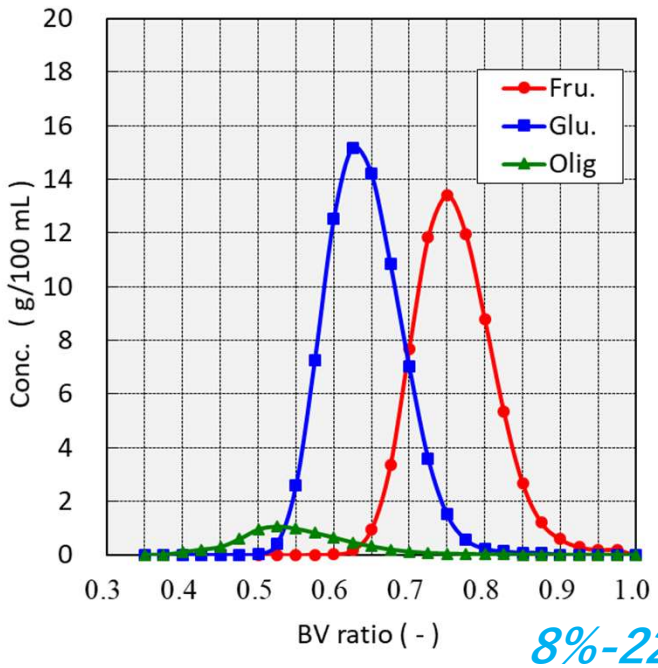
DIAION UBK Family has many achievements in the world for its stable quality.

Product Name	Cross-linkage (%)	Particle Size (μm)	Ionic Form
UBK510L	4	320	Na
UBK522M	5	300	K
UBK522K	5	360	K
UBK530	6	220	Na
UBK530J	6	280	Na
UBK530L	6	320	Na
UBK530K	6	360	Na
UBK532	6	220	K
UBK532J	6	280	K

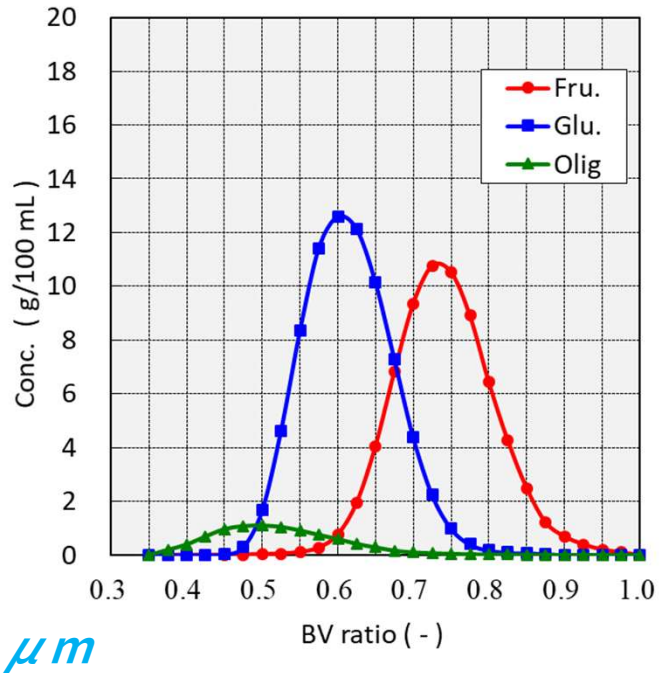
Product Name	Cross-linkage (%)	Particle Size (μm)	Ionic Form
UBK532L	6	320	K
UBK532K	6	360	K
UBK535	6	220	Ca
UBK535J	6	280	Ca
UBK535L	6	320	Ca
UBK535K	6	360	Ca
UBK550	8	220	Na
UBK552	8	220	K
UBK555	8	220	Ca

UBK grades other than the above (with different cross-linkage %, particle size and ionic form) are also available upon request.

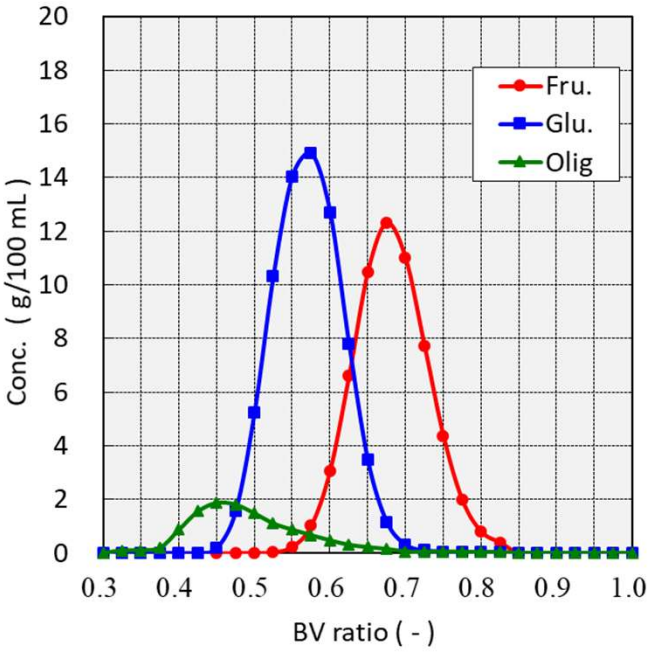
6%-280 μm



6%-320 μm



8%-220 μm



ISMB simulation
Load = 0.09 hr^{-1}, Water/Feed = 1.5 (v/v)

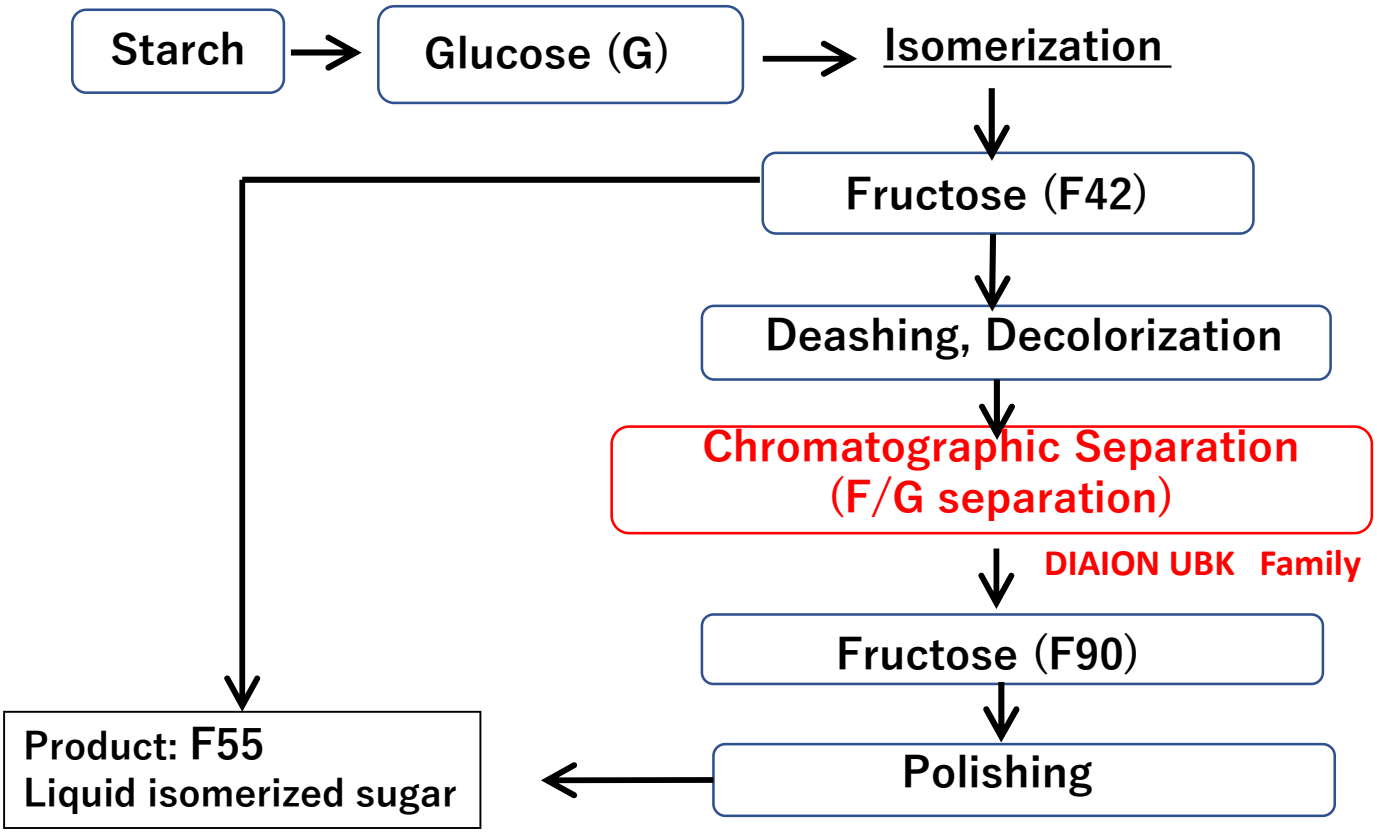
Resin	Purity	Recovery
8%-220 μm	96.1%	94.6%
6%-280 μm	96.0%	93.4%
6%-320 μm	96.0%	87.6%

【糖分離におけるクロマトグラフィー】
構造が似ている糖同士の分離や、重合度の異なるオリゴ糖などでは、クロマトグラフィーによる工業的な分離が多く用いられています。
代表的なクロマトグラフィーを用いる分離プロセス例を以下に示しました。

〇モラセスからのショ糖回収
〇果糖／ブドウ糖の分離
〇オリゴ糖（トレハロース、マルトース、マルトオリゴ糖、フラクトオリゴ糖等）の分離
〇糖アルコール（マルチトール、マンニトール、エリスリトール、キシリトール、ソルビトール）の分離
〇難消化性デキストリン、希少糖（アルロース等）、イヌリン（天然多糖類）の分離

このような分離には、単塔式（回分式）のクロマト分離では製造効率が低いため、擬似移動床法など、連続式のクロマト分離装置が用いられます。

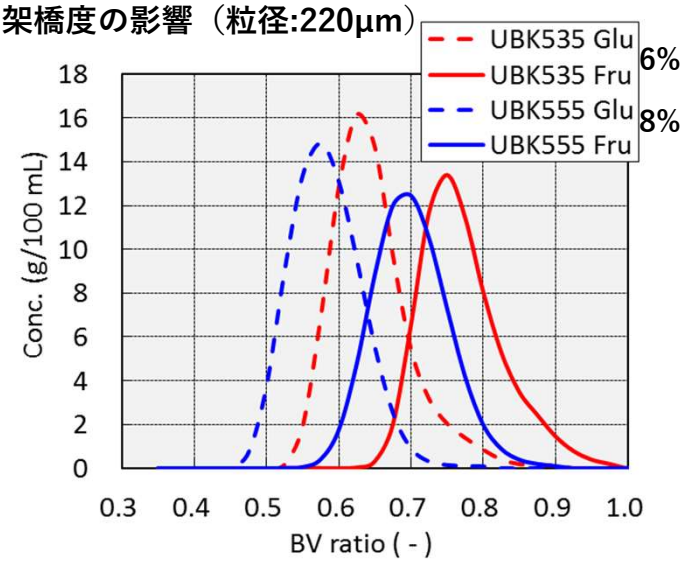
【クロマト分離プロセス例】
以下に果糖/ブドウ糖のクロマト分離プロセスを紹介します。
清涼飲料などに多く用いられる異性化糖はグルコースを酵素を用いて果糖にすることにより製造されますが、そのままでは果糖の純度は42%程度（F42 と表記する）にしか上がりません。蔗糖と同じ甘さにするには果糖純度を55%（F55)に上げる必要があります。このプロセスの概要を以下に示しました。



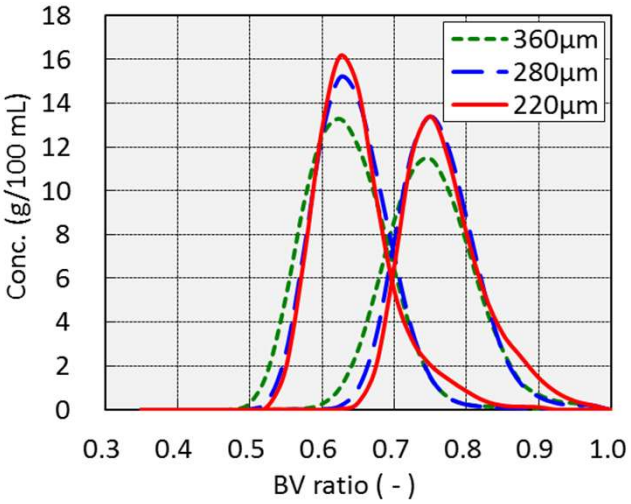
F55の製造プロセスは原料デンプンを酵素で分解してブドウ糖を得る工程、ブドウ糖を異性化、精製、濃縮してF42%を得る工程、F42%を脱塩・脱色してからクロマト分離（F/G分離）してF90%を得る工程、そしてこれをF42%と混合し、F55%とする工程からなっています。
DIAION UBKはこのプロセスの中で最も重要なクロマト分離工程で世界中で40年以上採用されています。

【分離性能へのUBKの架橋度、粒径の影響】F/G分離例
均一粒径樹脂であるUBKの架橋度と粒径が、果糖／ブドウ糖（F/G） 分離性能に与える影響を下図に示した。分離性能に関しては、架橋度が低い方が高く（６％＞８％）、また粒径が小さい方が高い（220 ＞ 280 ＞ 360 μm）。

架橋度の影響（粒径:220μm）



粒径の影響（架橋度: 6 %）



均一粒径樹脂であるUBK Familyにはクロマト分離の対象や条件に応じた多くのグレードがあります。異性化糖の分離にはCaイオン形が、ビート糖のクロマト精製にはK形が、乳糖のクロマト除去にはNa形が多く用いられます。また、クロマト分離性能とシステム運転の容易さの観点から、種々のグレードを揃えています。下表に、架橋度、粒径、イオン形が異なるグレードの代表例を示しました。DIAION UBK Family は、その品質安定性で、世界で多くの実績を有しています。

Product Name	DVB (%)	Particle Size (μm)	Ionic Form
UBK510L	4	320	Na
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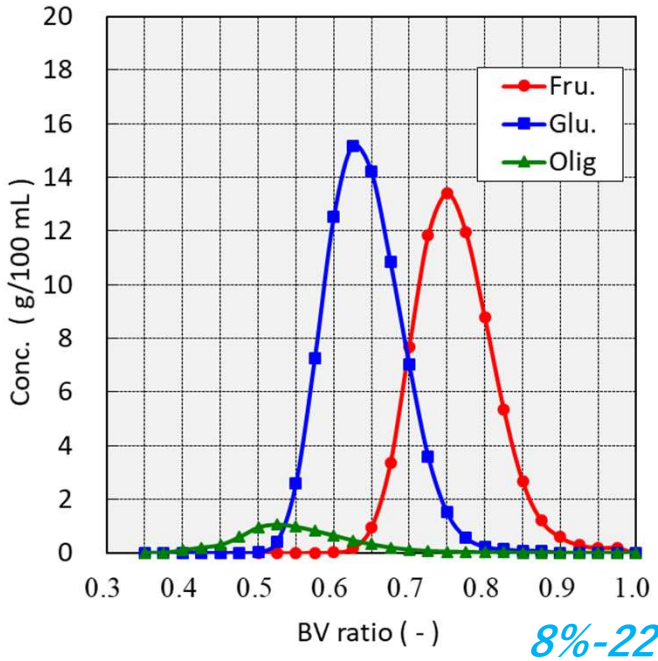
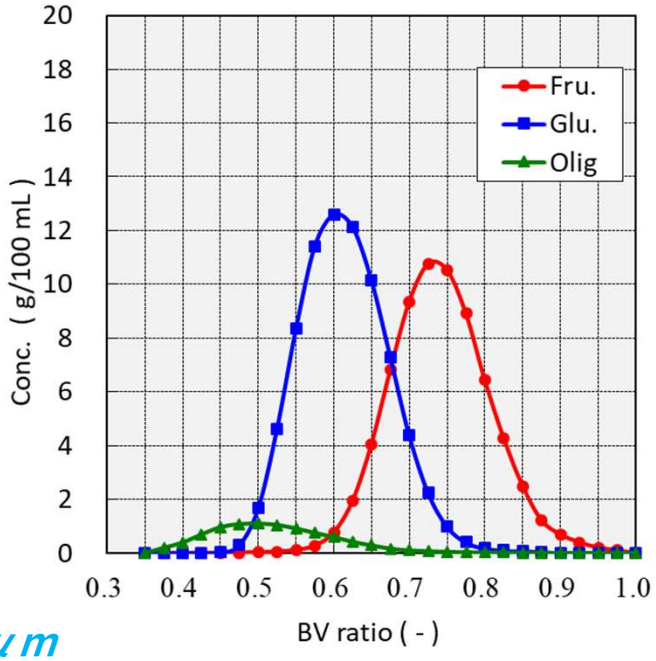
UBK550	8	220	Na
UBK552	8	220	K
UBK555	8	220	Ca

尚、上記以外の樹脂（架橋度、粒径、イオン形）も、ご要望に応じて対応可能です。

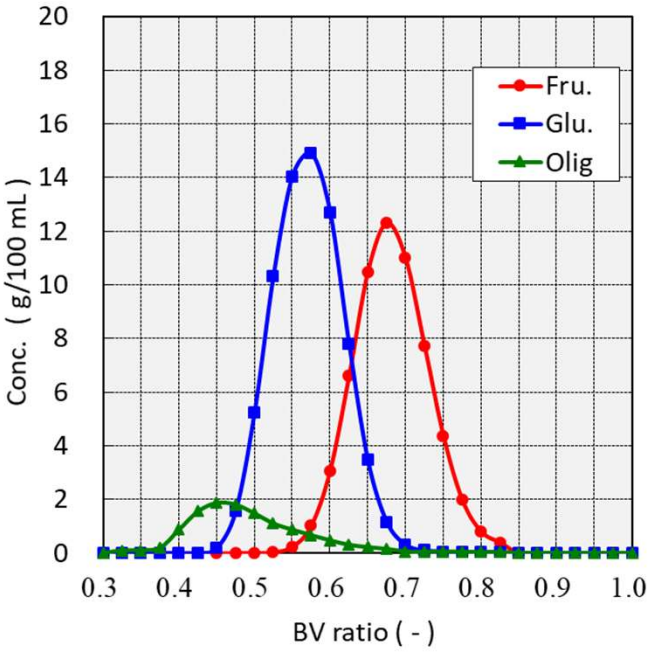
6%-280 μm



6%-320 μm



8%-220 μm



ISMB simulation
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