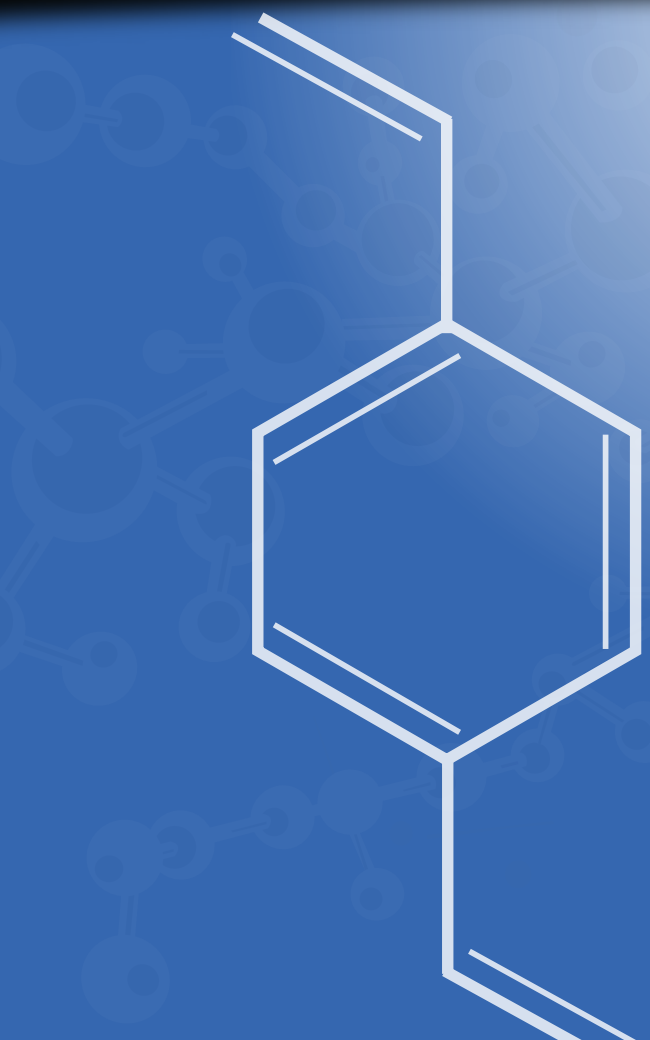
Jordi Labs

Material Solutions. Uncompromising Integrity.

# Resolve 5 µm GPC Columns



## Organic and Aqueous GPC

- Monodisperse polymer particles
- Linear over a broad range
- Long lasting, consistent performance

# INTRODUCTION

Jordi Labs specializes in the production of innovative polymeric media for Gel Permeation (GPC) and Gel Filtration (GFC) Chromatography.

Our GPC and GFC columns represent over 35 years of continuous research and development efforts. Jordi resins are always crafted using high quality 100% divinylbenzene (DVB) or other crosslinkable packings.

Jordi also operates one of the largest premier GPC service laboratories in the country. Our team's recognized analytical expertise and dedication to customer satisfaction has significantly influenced the development of our revolutionary column media. Jordi's unwavering commitment to quality and integrity is a promise that you are getting the finest GPC and GFC columns on the market today. We pride ourselves on delivering the best chromatography products and services, and offering expert support and advice to ensure your success.

## Background of SEC

Size exclusion chromatography (SEC) is a broad term which refers to size-based separation techniques, including GPC and GFC. The basis of these techniques is the separation of molecules by differences in hydrodynamic volume, or molecular size in solution. GPC and GFC offer molecular weight determination for polymeric solutions, as well as a method for the separation of components with significant size differences. GFC is applicable to separations performed in aqueous mobile phases, typically for the analysis of proteins or water soluble polymers. GPC is performed in organic mobile phases and is a common choice for the separation of synthetic polymers. Jordi offers a wide selection of GPC and GFC columns for all modes of SEC.

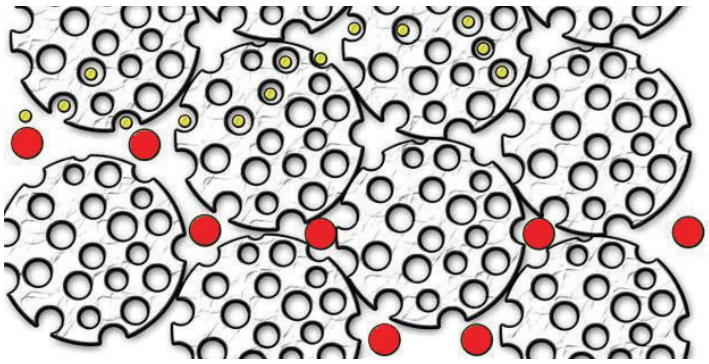


Figure 1 : The path of two different sized molecules passing through an SEC column

SEC consists of passing a sample solution through a porous media. Larger molecules that cannot access some of the pores within the media exit the column more rapidly, since they are excluded from some of the pores. Smaller molecules are able to penetrate into more of the porous structure, resulting in higher retention and later elution times. **Figure 1** shows the path of two different-sized molecules passing through an SEC column.

The porous media cannot accommodate the red (larger) molecules, thus the red molecules elute more easily and at faster times. The yellow (smaller) molecules fit into all the pores of the gel increasing the time required to pass through the column. SEC is unique in that GPC and GFC separations do not depend on interactions between the stationary phase and the sample, unlike common reversed-phase (RP) chromatography techniques. RP separations rely on differences in the hydrophobic interactions between the column and sample components. In SEC, sample-column interactions are undesirable because they prevent purely size-based separations.

### Key Features

No Dislocations in Pore Distribution
Clean Light Scattering Background
Highly Symmetrical Peaks
Improved Calibration

Low Back Pressure
Stable up to 220°C
Long Column Life

Repeatability
Plate Count
Resolution

## Jordi SEC

Choosing the right Jordi column for your application is easy. Our extensive application database contains hundreds of methods for the analysis of nearly all commercially available polymers. You can search by polymer name and method through Jordi's complete database, available at **http://bit.ly/JordiApps**. Alternatively, our team of chemists is available at any time by phone at **508-425-4347** or by email at **info@jordilabs.com** to help you custom design your SEC method, and to select the Jordi column set that is right for you. Please contact us today to receive your free copy of the Jordi application database.

## Jordi Resolve Organic GPC Columns

Jordi Labs has recently developed a novel packing material for GPC systems. This column packing is based on 100% divinylbenzene providing enhanced mechanical stability and utilizes a new synthetic process which results in a monodisperse polymer column packing. It is well known that broad particle size distributions in particle based columns produces variations in packing density, lowers column resolution, reduces the column permeability and generates high back pressure. New generation Jordi GPC columns prepared with monodisperse 100% divinylbenzene particles with precisely controlled particle diameter and finely controlled pore structure provide high efficiency, high separation capacity and low back pressure with greater bed stability. Scanning electron micrographs and particle size distribution of 5 µm macroporous column packing material with $10^3$ A pore sizes are shown in **Figure 2**. The uniform size distribution and perfect spherical shapes are clearly seen.

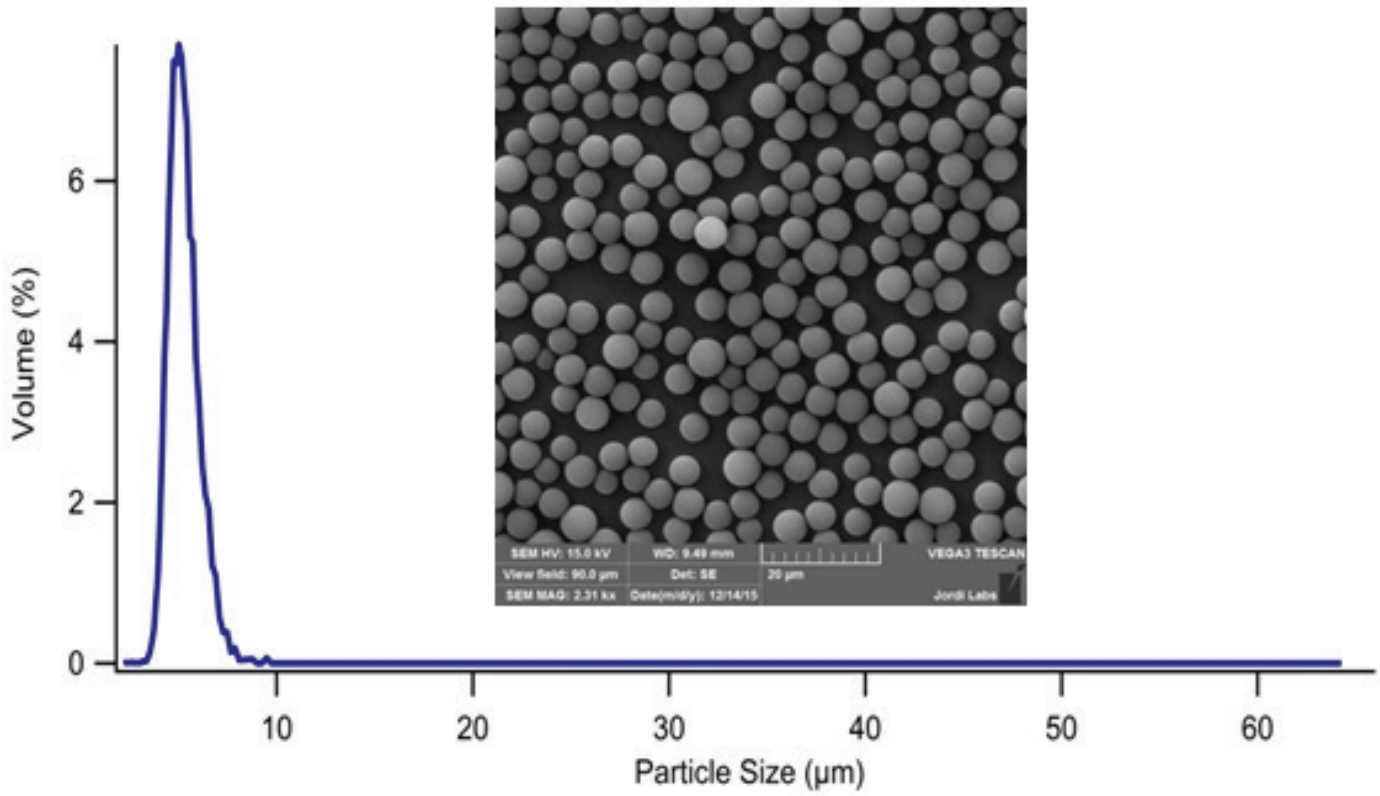



Figure 2: SEM and particle size distribution of Jordi Resolve 5 µm column packing material.

To maximize GPC resolution, the key is to use a column containing the maximum number of pores of the desired size to separate the molecular weight range of interest. New generation individual pore size Jordi Resolve columns 5 µm (7.8 mm ID x 300 mm L) provide high resolution in the specific molecular weight ranges given in **Table 1**.

| P/N | POROSITY | PRESSURE | MW RANGE |
|---|---|---|---|
| R15070 | 100Å | 8,000 psi | 200 – 10K |
| R15071 | 500Å | 8,000 psi | 200 – 15K |
| R15072 | $10^3$Å | 8,000 psi | 500 – 50K |
| R15073 | $10^4$Å | 2,000 psi | 30K – 600K |
| R15074 | $10^5$Å | 2,000 psi | 70K – 3M |
| R15075 | Mixed Bed Low | 2,000 psi | 200 – 600K |
| R15076 | Mixed Bed Medium | 2,000 psi | 200 – 3M |
| R15077 | Mixed Bed High *13 µm | 2,000 psi | 500 – 12M |

Table 1: Jordi Resolve DVB Specifications

The linear part of each calibration curve defines the molecular weight range of each individual porosity column. To cover a wider range of molecular weight with a constant resolution for the analysis of polydisperse or unknown materials, Jordi Labs designed mixed bed Resolve column 5 µm (7.8 mm ID x 300 mm L). Mixed bed Resolve column allows separation over the molecular weight range from 200 to 3,000,000 g/mol (PS equivalent) with a coefficient of determination ($R^2$) of 0.999, as shown in **Figure 3**. In addition, the high pore volume of Jordi Resolve column provides increased resolution compared to the competitive columns of the same particle size and length. Accurate blending of individual pore sizes and therefore, the wide molecular weight resolving range of Jordi Resolve columns provides smooth peak shapes.

For higher molecular weights, Jordi Labs offers its Jordi Resolve DVB 13 µm columns. New generation Jordi Resolve columns (7.8 mm x 300 mm) are produced to allow separation over the molecular weight range from 500 to 12,000,000 g/mol (PS equivalent). Polyolefins often have broad molecular weight ranges characterized by high polydispersity values. Jordi Labs has developed mixed bed columns especially for these broad distribution samples which were designed by blending a large number of individual pore size packing materials.

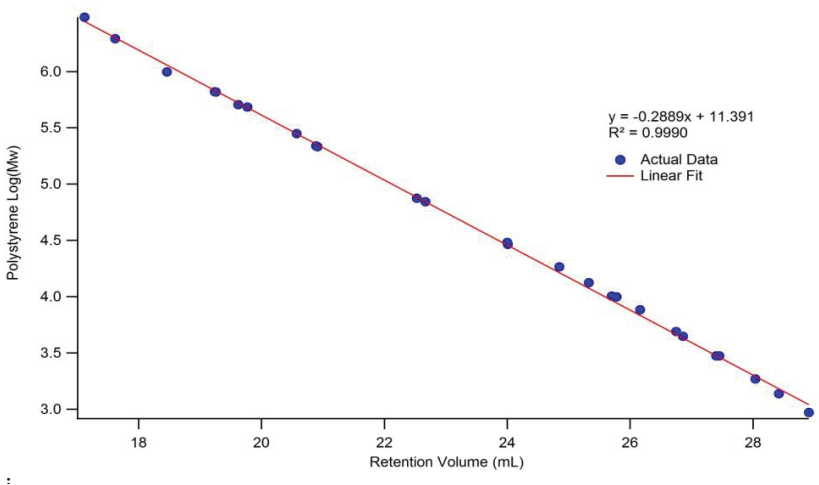



Figure 3: Resolve Mixed Bed Calibration Curve

## Jordi Resolve Aqueous GFC Columns

Jordi offers three column chemistries for GFC in aqueous mobile phases including:

1. *Jordi Resolve xStream*
2. *Jordi Resolve Anion*
3. *Jordi Resolve Cation*

Aqueous applications present a significant challenge in the field of size-based separations, due to the difficulty in preventing sample- column interactions. Jordi offers a wide selection of column packings to ensure success in your aqueous SEC separation.

Jordi Resolve xStream columns allow for the separation of a wide range of samples in 100% aqueous, 100% organic or aqueous/organic mobile phases. Our Resolve Anion and Resolve Cation columns separate cationic and anionic samples based on charge-charge repulsions, without the need for high salt concentrations.

The Jordi Resolve xStream column packing is an exciting breakthrough technology, which has increased hydrophilicity to reduce sample-column interactions. This novel resin features 100% polymeric polyamide chemistry. The Jordi Resolve xStream column, unlike typical GPC columns, performs well in any range of mobile phases, including 100% aqueous, 100% organic or any mixture of solvents. This new column is optimized for use in aqueous-based mobile phases and has the unique ability to separate a variety of cationic and polar polymers.

Jordi Resolve xStream columns apply to a wide range of neutral, polar synthetic polymers and polysaccharides in mixed mobile phases, such as DMSO/H2O. The extreme inertness of these packings extends their use to strongly basic mobile phases, including 1M NaOH, that would destroy the competitors' methacrylate-based products. Dextrans, polysaccharides and vinyl ether/maleic acid copolymers prove to separate well on the Jordi Resolve xStream, as shown in **Figure 4**. Separations in THF include, but are not limited to, phenoxy resins, poly(n-butyl methacrylate), polycaprolactone, several styrenic polymers, PMMA and other methacrylic polymers. The Jordi Resolve xStream is also appropriate for analysis in HFIP, eliminating sample-column interactions and providing excellent resolution in the separation of nylons and PET. Other organic mobile phases, such as chloroform, DMSO, DMAC and DMF can also be used on Jordi Resolve xStream columns.

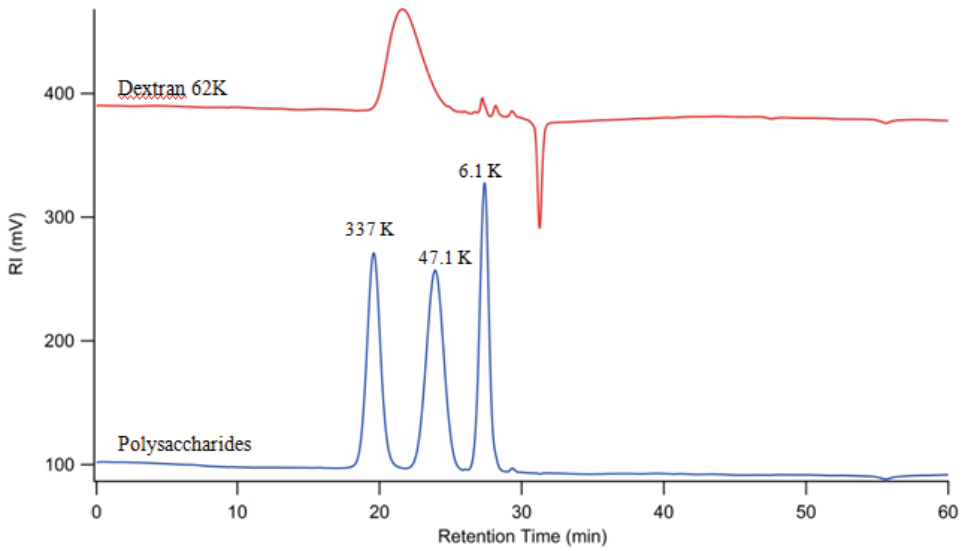



Figure 4: Polysaccharides and Dextran on Resolve xStream Mixed Bed Columns in Sodium Phosphate Buffer Solution (100mm, pH 7)

Jordi Resolve Anion and Resolve Cation columns apply to the separation of charged polymers without the need for high salt concentrations. These columns are an excellent choice for light scattering analyses, where high salt concentrations compromise system performance. Jordi Anion columns have a negatively charged surface for the separation of anionic polymers, such as poly(styrene sulfonate), as shown in **Figure 6**. Typical solvents for this phase include aqueous/organic mixtures, such as water/methanol.

Jordi Resolve Cation columns have a tertiary amine group, which in weakly acidic mobile phases converts to the positively charged quaternary amine. Common applications include the separation of amine polymers, such as poly(ethyleneimine) in water/acetic acid solutions. Several poly(2-vinylpyridine) standards are shown in **Figure 7.**

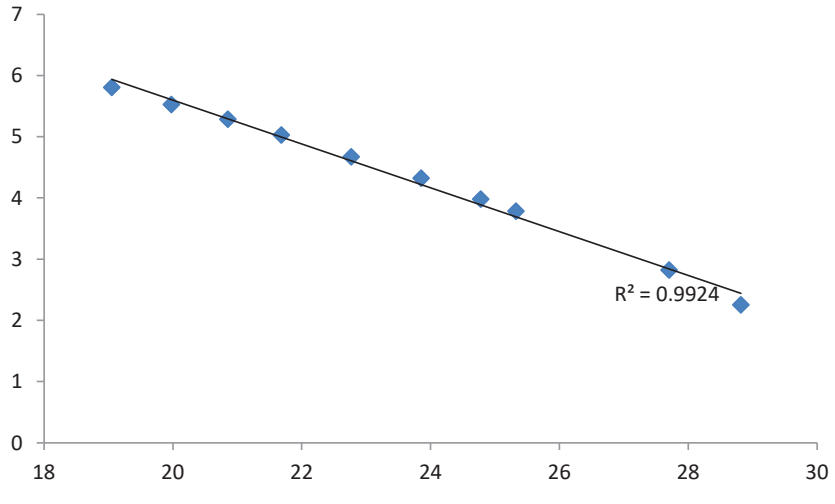



Figure 5: Example of Resolve Aqueous Mixed Bed Calibration Curve (180 - 642KDa)

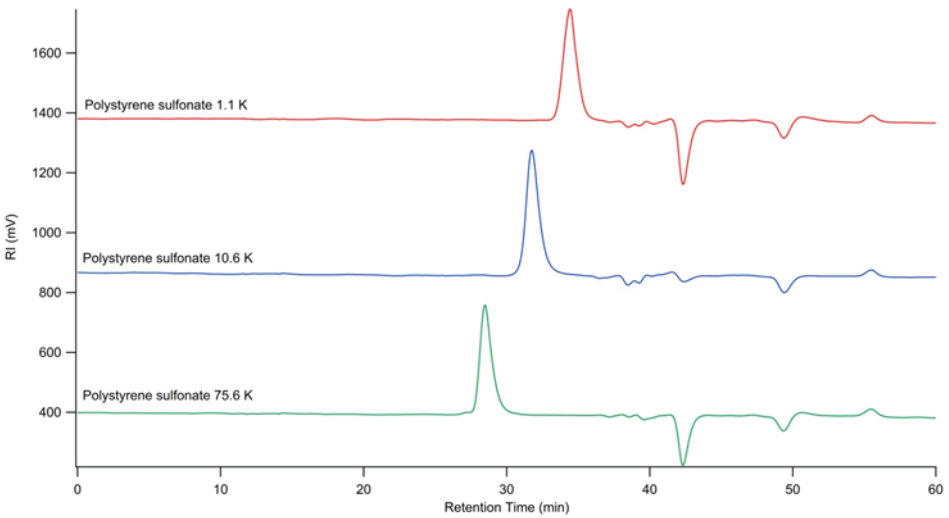



Figure 6: Poly(styrene) sulfonates on Resolve Anion Mixed Bed Columns

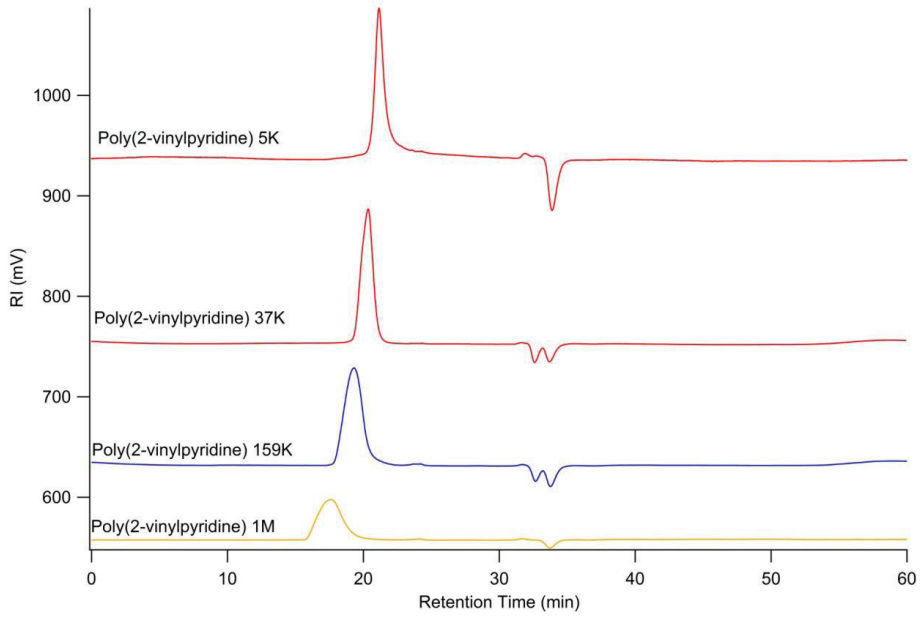



Figure 7: Poly(2-Vinylpyridine) on Resolve Cation Mixed Bed Columns in Water/Acetic Acid (90/10)

**Table 2** contains the typical MW ranges for Jordi Resolve aqueous columns. The range is dependent on sample and mobile phase.

| P/N | PHASE | POROSITY | PRESSURE | MW RANGE |
|---|---|---|---|---|
| R33061 | xStream | 500Å | 8,000 psi | 200 – 15K |
| R33066 | xStream | Mixed Bed | 2,000 psi | 200 – 1M |
| R15701 | Cation | 500Å | 8,000 psi | 200 – 15K |
| R15706 | Cation | Mixed Bed | 2,000 psi | 200 – 1M |
| R15721 | Anion | 500Å | 8,000 psi | 200 – 15K |
| R15726 | Anion | Mixed Bed | 2,000 psi | 200 – 1M |

Table 2: Jordi Resolve Aqueous Specifications

# Jordi Labs

*A leader in polyethylene analysis*

- Extensive polyolefin characterization experience
- Investigative analyses
- Regulatory submissions
- Extractables and Leachables
- Deformulation
- Best contract high temperature GPC lab

## Polymer Branching

- NMR (short chain, PE ID)
- TREF/CRYSTAF (branching comparisons)
- GPC-T (long chain branching)

## Additives Package

- QTOF-MS (additive type and quantity)
- TGA (filler content)
- SEM-EDX (filler type and size)

## Thermal Properties

- DSC (melt point, glass transition)
- Capillary Rheometry (extrusion properties)
- Melt Flow

## Mw Characterization

- GPC-H (relative molecular weight)
- GPC-HT (absolute molecular weight)

## Film Characterization

- FTIR-Microscopy (film layer structure)
- SEM (film layer thickness)