An approach to sustainability: The characterization of polyolefin recyclates

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With almost 370 million tons of plastic produced worldwide in 2019, plastic recycling is becoming increasingly important.
Essential for recycling, which should go beyond energy recovery, is the separation into so-called pure fractions in the first step.
A clear difference can be seen here between post-consumer and post-industrial waste. Post-industrial waste is usually "single-type", i.e. it usually consists of only one type of plastic such as PE, PP, PVC, PET, etc.
It's different with PCR's. These are mixed wastes made from the most diverse types of polymers, partly from composite materials. The separation and analytical requirements are correspondingly greater.

PCRs are sorted and identified using infrared spectroscopy (usually near infrared). However, this sorting can be incomplete (especially in the case of composite materials). Before such processed materials are used again, a more in-depth analysis is recommended.

The polyolefine polypropylene (PP) is one of the most common macromolecules on the polymer market. It is used widely in packing, for containers and housings, but also in automotive interior and further more applications.
Recycling of polyolefins starts to play an important role lately. Especially, the comparison between new and recycled material is a future task. The macroscopic behavior of recycled PP compared to conventional PP needs to be understood and characterization with GPC/SEC is essential.
GPC/SEC analysis of PP requires high-temperature GPC/SEC for characterization since it is only soluble at elevated temperatures, e.g.1,2,4 trichlorobenzene is a typical mobile phase, which is used at 160°C.
Typically, GPC/SEC is used for analysis of molar mass distribution and to determine structural properties like copolymer analysis. However, the behavior of material, which is based on recyclates, depends not only on molar mass, but also on structure, potential impurities, and content of antioxidants.

The type purity with regard to the chemical composition of plastics/polymers is just one important property. In the case of polymers, the material properties are also influenced by their molar mass distribution. Melting point, strength, melt viscosity and many other parameters depend on the molar mass distribution. Ideally, the molar mass distribution can be determined using GPC. If new material is to be replaced by recyclates in a product made of plastic, GPC can be a great help as a quick and effective method, especially during development.
In addition to the molar mass, GPC can also provide information about the chemical composition (polymers, additives, decomposition products) in combination with various detectors (UV, infrared, viscosity) or other chromatographic methods (HPLC, TGIC).

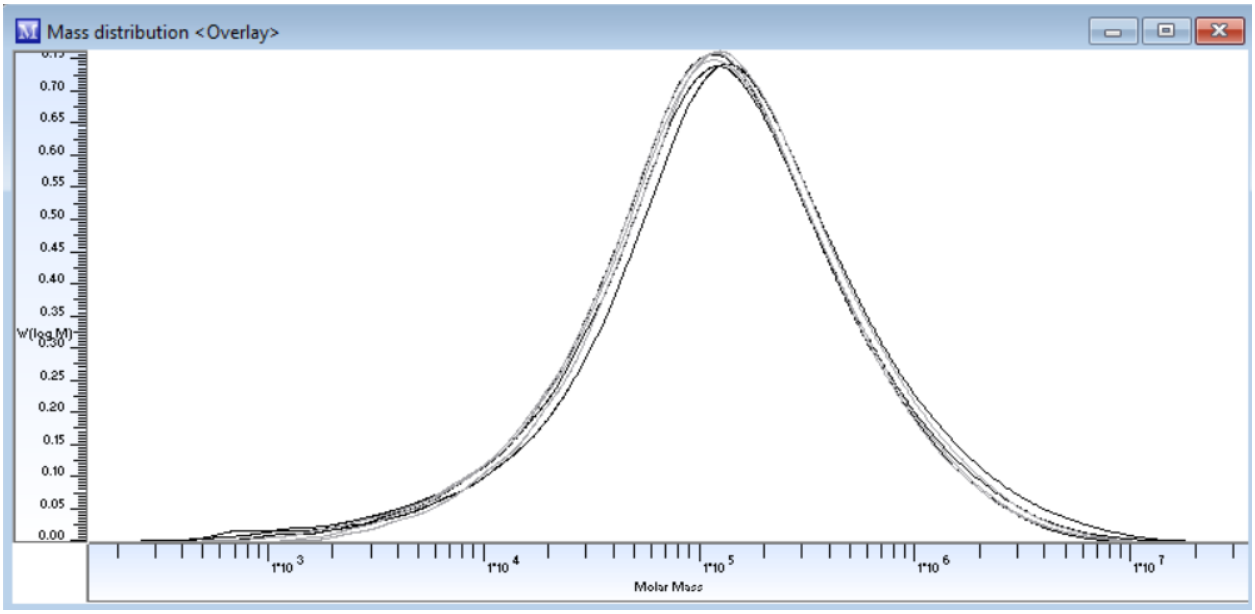

Figure 1: Comparison of the molecular weight distribution (based on calibration with PS reference materials) of each three samples of new PP (grey lines) and recycled PP (black lines)