DESIGNING POLYOLEFIN PROPERTIES FOR 3D PRINTING APPLICATION

Gunnar Spiegel, Christian Paulik

Institute for Chemical Technology of Organic Materials, JKU, 4040 Linz, Austria

Production technologies are changing and with it the requirements for material diversity and properties are increasing. 3D-printing exhibits great flexibility for rapid prototyping and small series, compared to injection molding.

Concerning the Fused Filament Fabrication (FFF) polyolefins offer a great perspective considering their versatility and fields of application. The most commonly sold materials acrylonitrile-butadiene-styrene (ABS) and polylactic-acid (PLA) are reliable in most cases [1]. Both materials have their advantages but in contrast to polyolefins they lack in terms of strain strength, temperature stability and moisture resistance. Moreover, polyolefin properties can be adjusted over a broad range and specifically be designed for an application.

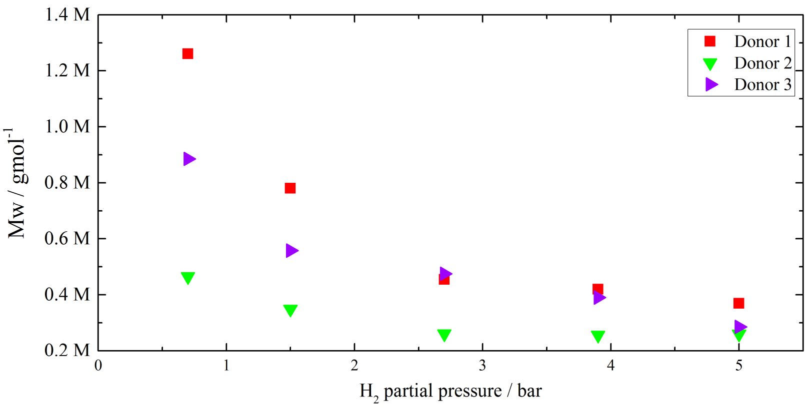

Figure 1: Molecular weight obtained by the use of various external donors in dependence of the applied H_2 partial pressure.

After identification of the most important properties influencing printability by analysis of different materials available for 3D-printing, the next step was to synthesize polypropylene based polymers using an in-house polymerization system. Hence a commercial 4th generation Ziegler-Natta catalyst was screened for effects of e.g.: external donor, H_2 partial pressure. Experiments were conducted via the one factor at a time approach and then compared to a design oriented approach, so the optimal polymerization conditions for the favored criteria could be narrowed down.

The analysis of commercially available materials revealed properties, which are necessary to translate into polyolefines to make them manageable for 3D-printing. The most suitable polymers were then blended and processed into filaments and their printability evaluated. It was shown that material property design can be supported using statistical tools.

[1] Gibson, I.; Rosen, D.W.; Stucker, B.: Additive Manufacturing Technologies, Rapid Prototyping to Direct Digital Manufacturing, Springer, New York, 2010