PRESS RELEASE

Polypropylene recyclates: best quality at minimum cost thanks to precise stabilisation

All organic substances, including plastics such as polypropylene (PP), undergo auto-oxidation in the presence of oxygen. This happens millions of times faster at the high temperatures of compounding and injection moulding. The result for PP is a degradation of the polymer chains, i.e. a reduction in molecular weight, which means that products made from these plastics can no longer be recycled. Antioxidants added during the manufacturing process slow down this degradation. Without these additives, many everyday objects could not be produced in a usable form. Researchers at Fraunhofer Institute for Structural Durability and System Reliability LBF have further improved the rheological online tests so that the exact additives can be determined more quickly, and the costs optimised.

Until now, when developing new compounds, the optimum proportion of antioxidants has been determined in extensive and therefore cost-intensive test series. Ultimately, the processor wants to optimise the properties of the plastic. However, lengthy pre-tests are not profitable when producing recyclate from old material batches with highly variable quality and varying residual stabiliser content. The approach of simply adding "enough" stabiliser is unsuitable or too costly for a consistent circular economy. There is also an upper limit for the compatibility of stabilisers with the polymer. This is because the plastic should not only have a second, but also a third, fourth etc. life. During each life cycle, the stabilisers are used up as intended, with their by-products remaining in the plastic. This makes it even more important to add only the necessary amount of stabiliser during recyclate production. Online rheological tests accelerate the process of achieving exact stabilisation and optimising costs.

Online characterisation for the stabilisation adapted to the recyclates

To obtain immediate information about the effectiveness of the stabiliser addition, the Fraunhofer researchers are taking the approach of characterising the melt *online* during compounding. Meaningful information on the processing behaviour of plastics can be obtained using an online rheometer. It measures the flow curves of both shear and elongational viscosity.

In initial tests at the Fraunhofer LBF, a marginally stabilised virgin PP served as a model polymer. A clear correlation was established between the viscosity values and the stabiliser concentration or the viscosity values and the molecular weight. Considering recyclates, one post-industrial and one post-consumer PP were analysed. The post-

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industrial PP from start-up material and sprues from injection moulding still has a high stabiliser content. This means that no significant improvements in preserving the molecular weight can be achieved here with stabiliser additions of more than 0.1 % - the flow curves for the stabiliser additions investigated are therefore almost on top of each other. In the post-consumer PP, the antioxidants are consumed to a high degree, which is associated with significant damage during processing, which is noticeable in a low viscosity/flow curve. For optimised stabilisation and minimised damage to the recyclate, an addition of 0.5 % additive is required here.

Making plastic formulations more profitable

The online rheological measurements can be used to draw meaningful conclusions about the number of antioxidants that should be added to the respective batch of used plastic. The online rheology presented here is available to Fraunhofer LBF project partners. Plastics processors thus receive immediate information on the effect of a process stabiliser and can produce their formulation more cost-effectively and make it more profitable.

In addition, the flow curves of the elongational viscosity reflect the stability of the melt. In contrast to shear viscosity, extensional viscosity is very sensitively influenced by the fibre content and fibre distribution. As melt stability is an important criterion for the use of a given compound for blow moulding processes, online rheology can also support the compound developer in this respect.

More information about the project: www.lbf.fraunhofer.de/online-rheologie

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Online rheology at Fraunhofer LBF supports compound developers and makes formulations more cost-effective. Photo: Fraunhofer LBF, Raapke

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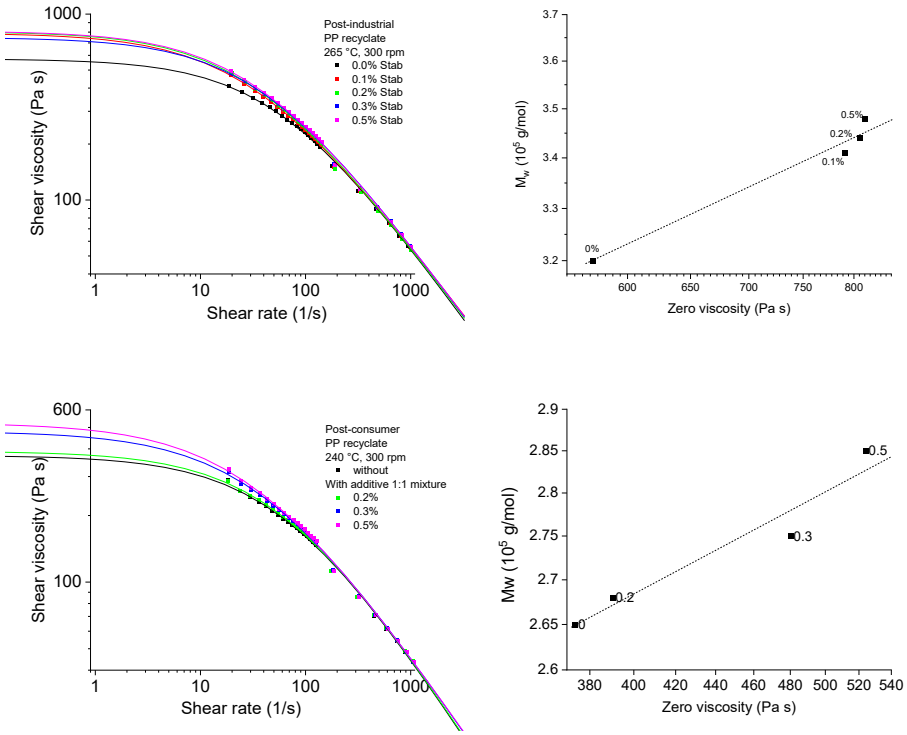

The upper images show the flow curves of the shear viscosity with different stabiliser content ("Stab") and the molar mass Mw as a function of the zero viscosity for a post-industrial recycling PP. The lower images refer to a post-consumer PP. Graphic: Fraunhofer LBF

Fraunhofer LBF in Darmstadt has been synonymous **with the safety and reliability of lightweight structures** for 85 years. With its expertise in the fields of fatigue strength, system reliability, vibration technology and polymer technology, the institute today offers solutions for three of the most important cross-cutting topics of the future: lightweight system design, functional integration and cyber-physical mechanical engineering systems. The focus is on solutions for social challenges such as resource efficiency and emission reduction as well as future mobility, such as electromobility and autonomous, networked driving. Comprehensive expertise ranging from data acquisition in real operational field use, data analysis and data interpretation to the derivation of concrete measures for the design and improvement of material, component and system properties form the basis for this. Clients come from sectors such as automotive and commercial vehicle construction, shipbuilding, aviation, mechanical and plant engineering, energy technology, electrical engineering, medical technology and the chemical industry. They benefit from the proven expertise of over 300 employees and state-of-the-art technology in more than 17,900 square metres of laboratory and testing space.

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