HIGH-VELOCITY STRETCHING TESTS OF POLYETHYLENE

Johanna Eichelter[a], Andreas Mautner[a], Alexander Bismarck[a,c], Andreas Eder[b], Harald Wilhelm[d], and Erhard Schaffler[e]

[a] *Polymer and Composite Engineering* (PaCE) group, Institute of Materials Chemistry and Research, Faculty of Chemistry, University of Vienna, Währinger Straβe 42, 1090 Vienna, Austria
[b] Franz S. Huemer GmbH (FSH), Wienerbergstraße 11/B16, 110 Vienna, Austria
[c] *Polymer and Composite Engineering* (PaCE) group, Department of Chemical Engineering, Imperial College London, South Kensington Campus, SW7 2AZ, London, UK
[d] Laboratory of Polymer Engineering (LKT-TGM), Wexstraße 19-23, 1200 Vienna, Austria
[e] Research Group Physics of Nanostructured Materials (PNM), Faculty of Physics, University of Vienna, Boltzmanngasse 5, 1090 Wien, Austria

Industrially produced stretched films and tapes from fossil raw materials are used for many packaging applications, such as heavy duty Big Bags or industrial weaves. Stretching of both amorphous and crystalline polymers in the solid state is defined as the elongation in one direction, which results in improved mechanical properties in the stretching direction. The fundamental requirement for the stretchability of polymers are linear i.e. unbranched macromolecules. Therefore stretchability of polyolefines for example branched polyethylene with low density (PE-LD) is lower than for polyethylene with high density (PE-HD).

Basic requirements for stretchability for thermoplastics are known, but the data about correlations between material parameters and stretching behavior are scarce. Mostly stretchability of materials was evaluated based on common tensile tests. There, stretching velocities are much lower (1-500 mm/min) than in industrial processes (200-1000 mm/s). Results from high-velocity stretching tests or stretching tests on production machines are not published. Until now it also was not investigated, if a "stretching velocity profile" results in improved mechanical properties. "Strain rate profile" means increasing velocity during stretching which results in a constant strain rate.

In this study correlations between material properties and stretching parameters of polymers were evaluated for PE-HD and PE-LD, by stretching polymer films at with high-velocity stretching tests (up to 800 mm/s). Furthermore, it was investigated, which stretching conditions (stretching velocity profile, temperature, stretching degree, sample geometry,…) result in maximum mechanical properties. It was found, that a higher film thickness and a higher stretching temperature result in better mechanical properties and a higher orientation of crystallites. Furthermore, it was found, that lower stretching degrees of about 80 % of the maximum stretching degree, also result in improved mechanical properties.