Enhanced Dielectric Properties

Motivation

Compounding and Extrusion in a one-step process (Fig. 1) allows to adjust the film properties in a targeted manner while reducing material degredation of thermoplastic base materials. A holistic view from granule to the finished film is relevant, as the physical properties of cast films, with unaltered material, can be greatly influenced by extrusion parameters and their interaction.

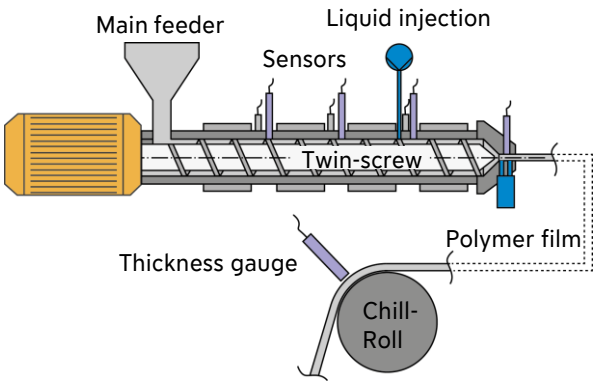

Fig. 1: Schematic illustration of the flat-film extrusion process with different sensor and feeding possibilities

Application

Modernization of the energy system is intended to facilitate the increasing integration of renewable energies and ensure an energy efficient, environmentally friendly supply in the future. In the expansion and restructuring of the power grids, a high level of supply security with consistently good supply quality is one of the basis for international competitiveness. Within this framework, innovative network operating resources ensure the availability and reliability of the supply. Power converters are becoming an essential component of the grid infrastructure, while Film capacitors made of biaxially oriented polypropylene (BOPP) as shown in Fig. 2, play a key role in voltage stabilization in most power converters.

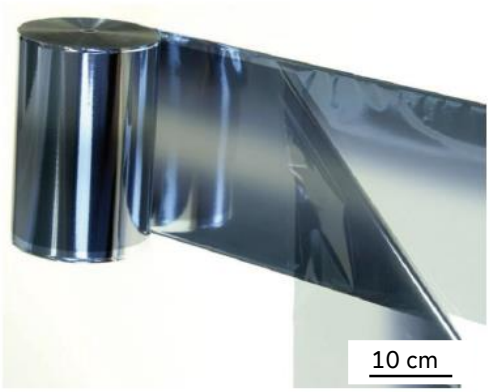

Fig. 2: Metallized BOPP-film winding for use in high-voltage film-capacitor

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Research focus

Finely dispersed nanoparticles can act as mutually isolated electron scavengers in the band gap between the valence and conduction bands and thereby increase the breakdown field strength of the films. Here, the balancing act between good dispersion and low material degradation is a great challenge.

Main research results

The application of nanoparticles in the necessary concentration (~ 0,5 wt.-%) onto a carrier material, such as cryogenic milled PP-powder, slurries or PP-fleece, is an effective solution to balance the goals of low material degradation during processing and high dispersion of SiO_2 particles in PP homopolymers.

By feeding the carrier material into a twin-screw extruder, which is connected to a flat-film die via a melt pump for homogenization of the volumetric flow, the thermal degradation of the material can be decreased further while increasing the efficiency of the process chain by avoiding a second process step.

The connection between predispersion for example on cryogenic milled PP (Fig. 3) and final dispersion result (Fig. 4) have been shown for a wide range of approaches. The product-quality can be characterized via SEM imaging and is reflected significantly in the measurement of Break-Down-Voltage (BDV) of BOPP Film. Gel permeation chromatography (GPC) measurements can illustrate the lower material degradation in a one-step extrusion process.

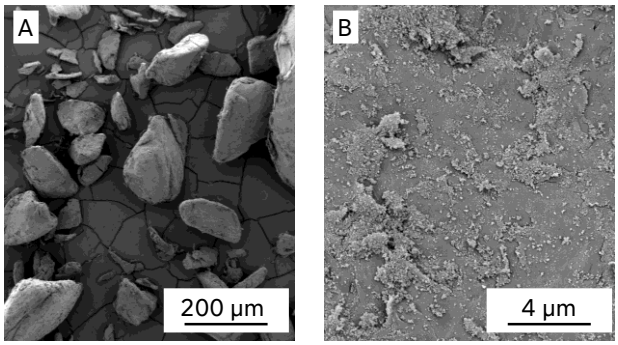

Fig. 3: SEM images of SiO_2 particles pre-dispersed on cryogenic milled PP-powder as carrier medium at different magnification:
A) magnification 250 x
B) magnification 25.000 x

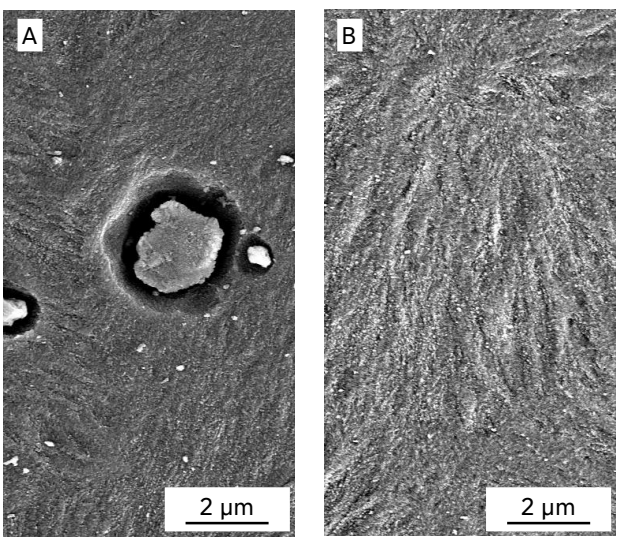

Fig. 4: SEM Image of 0,5 wt.-% SiO_2 particles in etched PP-castfilm after gentle processing:
A) agglomerate without predispersion
B) improved dispersion through the use of predispersion on cryogenic milled PP-powder

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