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Recycling in Thermoforming

Motivation

Due to the lack of raw material and forced by political demand, an increasing percentage of postconsumer materials (PCR) shall be used in all processing methods in polymer technology. Current statistics from the Federal Environment Agency show that there is still unused potential in the reprocessing of polymers. In 2017, a total of 14 million tons of polymer was processed, out of which only 6 million tons were recycled (Fig. 1). Efforts are made to create a circular economy (Fig. 2). Due to the unknown origin and the seasonal effect on the material properties, the acceptance of PCR materials for further reprocessing is currently still very low in the polymer processing industry. Thermoforming, as one of the oldest polymer processing methods, has special requirements regarding the melt stability at high temperatures, so that PCR materials cannot be applied.

Application

The main area of application for thermoformed products can be found in the packaging industry. In the technical field, items such as dash-boards or door linings are produced by thermoforming. and is though a potential field for PCR materials.

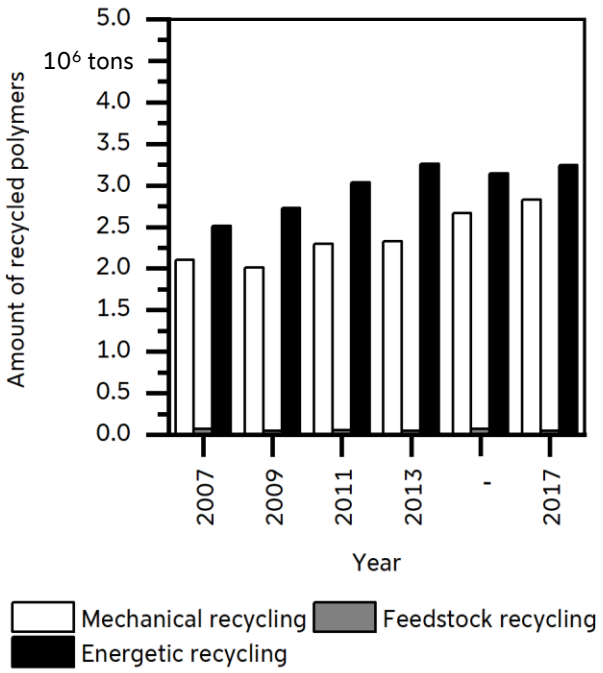

Fig. 1: Polymer recycling

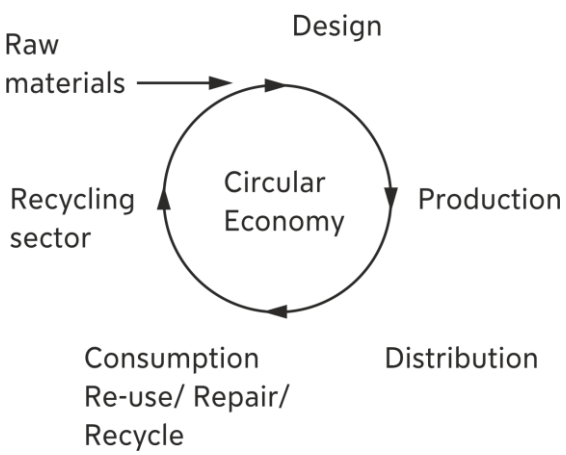

Fig. 2: Circular economy of polymer products

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Research focus

The focus of current research activities is to identify the challenges and potential of using coextruded two-layer sheets in the processing of PCR in thermoforming applications. Particular attention is given to the relationships between PCR quality, process-related material properties and resulting part properties. Extruding materials with different viscosities and thermoforming materials with low melt stability are a major challenge.

These investigations aim to enable non thermoformable materials, such as recycled items, to be suitable for the thermoforming process by using a multilayer sheet structure. A multilayer sheet shall create a stabilizing layer that prevents the sheet from sagging.

Main research results

The presence of an unstable layer as known from PCR materials can be compensated by choosing a material with a as high as possible viscosity.

The layer content and the viscosity grade of the PCR material seem to have less influence on the stretching process, see . Thermoforming of materials that have not yet been thermoformable, with a storage modulus of less than 10^3 N/mm² and a ratio between storage and loss modulus greater than 1, becomes possible using a two-layer sheet independent of the layer ratio. If the layer with higher viscosity acts as a stabilizing layer, thermoforming is possible (Fig. 3).

The elongation behavior is significantly influenced by the highly viscous material (Fig. 4). Thus, two-layer sheets can be used as a suitable method for stretching processes under elevated temperatures of less viscous materials, as known from recycling.

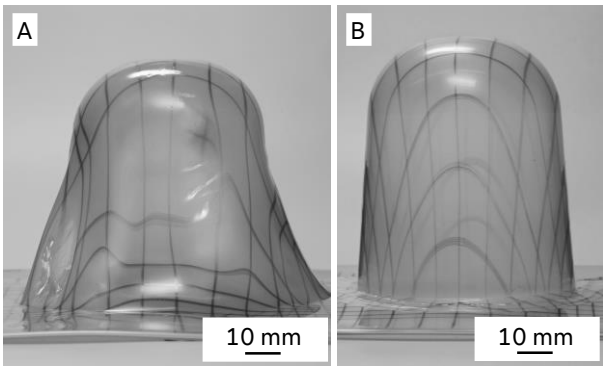

Fig. 3: Rotational symmetric thermoformed parts: A) monolayer of non thermoformable material B) 2-layer sheet containing non thermoformable material

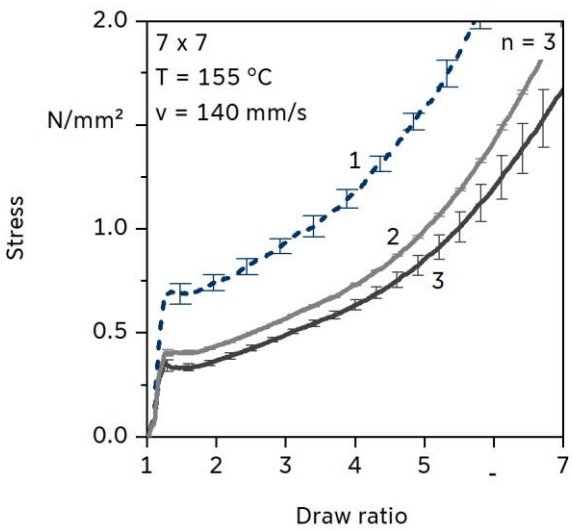

Fig. 4: Biaxiale stretching tests of two layer sheets containing non thermoformable materials

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