

Mechanical recycling of multilayer films made of Polyethylen (PE) and Polyamid (PA)

Trial Concepts:

1. definition and production of multilayer films made of polyethylene and polyamide with a maximum content of 30 percent (co)PA (e.g. Ultramid® B40LN, C40L). Some of the original structures already contained incorporated compatibilizers
2. Regranulation of the films with the help of a standard NGR regranulation system
3. Analysis of the morphology of the regranulates
4. Compounding of defined mixtures of the produced regranulates with reference polyethylenes according to test standard of cyclos-HTP (part of certification project with Institut cyclos-HTP GmbH)
5. Production of monoblastic films (40 µm) on a semi-industrial scale. Here, use of the regranulates as a blend with PE regranulates and/or compatibilizers during the manufacturing process combined with a dilution approach to quantify processing limits of the polymer blends used
6. Production of monoblastic films (40 µm) and injection-molded test specimens using the compounds produced under point 4 (part of the certification project with Institut cyclos-HTP GmbH)
7. Analysis of the mechanical and optical properties as well as the sealability and tightness of the monobloc films and the mechanical properties of the injection molded test specimens. (Partial component of the certification project with Institut cyclos-HTP GmbH)
8. Use of selected regranulates and blends for the production of regranulate-containing multilayer films and determination of the mechanical and optical properties as well as the stippling level of these film structures

Trial Results:

- PA6 (Ultramid B) is "recycling compatible" in the PE film waste stream (certified by Institut cyclos-HTP GmbH for structures with up to 30 percent coextruded PA6)
- Due to the lower melting points and crystallinity of PA 6/6.6, this also applies to this type of CoPolyamides (CoPA, Ultramid C grades)
- PE/(Co)PA blends are miscible at a PA content of < 10 percent without adding additional compatibilizers
- The use of suitable compatibilizers is an efficient method to produce homogeneous PE/(Co)PA blends with a PA concentration of > 10 percent. In our test series, PE/PA blends with a (Co)PA content of up to 30 percent could be efficiently homogenized by adding 2-5 percent of modifier

- Maleic anhydride-grafted polyethylenes have proven to be particularly suitable compatibilizers. The required quantity may
 - already be contained in the original multilayer film (precompatibilization),
 - added during regranulation in the standard single-screw extruder or
 - added as a single component immediately before the final film production from regranulates.
- When using industrial PE/(Co)PA film waste (PIR), mono films can be produced using 100 % PE/(Co)PA regranulate blends or core layers of highly concentrated PE/PA regranulates can be realized in multilayer films. Surprisingly good mechanical and optical properties can already be achieved without using a twin-screw extruder
- PE/(Co)PA containing polymer blends from post-consumer packaging waste (PCR) can be further processed into injection molded articles as well as films without additional drying steps at mixing ratios and temperature profiles commonly used in the PE recycling process
- Coextruded PE/PA6 multilayer films with up to 30 percent PA6 are currently certified by Institut cyclos-HTP GmbH with up to 70 percent (for non-compatible formulations) and up to 100 percent (for pre-compatible structures) recyclability