Impact-modified polyamide compounds



KTCK blenz Kunststoff-Technologie-Institut

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Collaboration between University Koblenz-Landau and AKRO-PLASTIC GmbH



AKRO-PLASTIC GmbH Member of the Feddersen Group

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Presentation of the collaboration members

AKRO-PLASTIC GmbH

- Plastic-compounder for engineering plastics
- Headquarter in Niederzissen Germany
- 400 employees
- Member of the K.D. Feddersen Holding GmbH, Hamburg, ca. 1500 employees
- Production facilities in Germany, China and Brazil



University Koblenz-Landau

- 2nd largest university in RLP (18 000 students)
- Material Physics Group located in the Natural Science Department, Campus Koblenz
- Kunststoff-Technologie Institut in cooperation with the Chamber of Trade









Impact strength

• Impact strength: Ability of a material to absorb impact energy



Areas of application of impact-modified materials

• Requirement: Tough material behavior over a wide temperature range



Glass transition temperature (T_g)

- Huge influence on the mechanical properties
- Below the Tg, the mobility of the molecular chains in the amorphous phase is largely frozen, and the materials behave brittle







*) https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcSiVK-LmF6U24HTBXRP1GmQjMn2M6X3rPcl4ikM3zNjmHAXTLXi5w

**) https://ae01.alicdn.com/kf/HTB16G5eQFXXXXUUXXXXq6xXFXXXL/10-ST-CKE-Schwarz-Draht-Fixiert-Clip-Auto-Linie-Clip-Selbstklebende-Kabel-Draht-Kl-ren-Clips.jpg_640x640q70.jpg

Impact modified polyamide-compounds

- Combination of different polymers (compounds)
 - Polyamide
 - Usage **below** T_g
 - High stiffness and strength
 - Elastomer based thermoplast
 - Usage **above** T_g
 - Tough mechanical behavior
- Usage of copolymers as soft phase
 - o For example ethylene and higher α -olefines
 - Composition of the copolymers can be varied

Micelle structure (PA + POE)



Process of compound development

Development of compounds



Reduction of iteration steps

*) http://www.maschinenbau-wissen.de/skript3/werkstofftechnik/kunststoffe/392-extrusion



Aim: Detailed insight into correlations between processing condition, resulting material structure and final properties of the compounds



Chemical structure

Ethylene based copolymers

- Copolymer shows small side chains, the length of which depends on used comonomer
- The choice and proportion of the comonomer influences, among other things the glass transition temperature and viscosity



Compatibilization

POE

PA

- Impact modified compounds
 - Combination of immiscible materials
 - Development of a two- or multiphasesystem
 - ightarrow Compatibilization is needed



*) Bonten, C., Kunststofftechnik: Einführung und Grundlagen, 2014, Carl Hanser Verlag GmbH & Company KG

**) Van Puyvelde, P., 2003, Effect of reactive compatibilization on the interfacial slip in nylon-6-EPR blends, Polym Eng Sci, 43: 71-77

Modifier content

Energy dissipation process

- Energy dissipation via crack initiation, -propagation and break
- "Critical thickness theory"
 - Stress concentration between the particles
 - Impact strength depends on the interparticle distance (ID)
 - The ID has to be below a critical value, which depends on the matrix used

ID is influenced by volume fraction and particle size of the modification







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Intercorrelation compatibilization, chemical structure, modifier content







Summary and plan

- **Conclusion:** Complex system with many influencing factors: Material properties and process parameters can influence each other
- **Approach:** Material and process parameters are changed systematically, to outline the influencing factors on structure-property relationships

• Aim: Target-oriented manufacturing of tailor-made compounds, with optimized material properties for new applications

Thank you for your attention