limited effect on thermal stability of not filled PP (Fig. 3).

In case of PP with reinforcement (PP 25% GF) the dose of irradiation is very significant. The raising dose of irradiation can influenced the temperature stability negatively (Fig. 4).

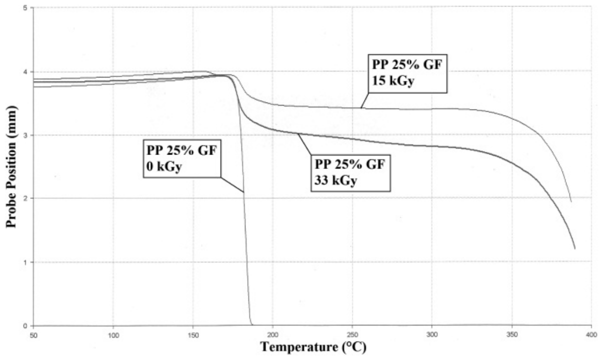

Fig. 4. **Temperature stability of PP 25 % GF**

Very similar results have been obtained by the irradiation of polyamide. The graph of TMA of Duramide is in Fig. 5.

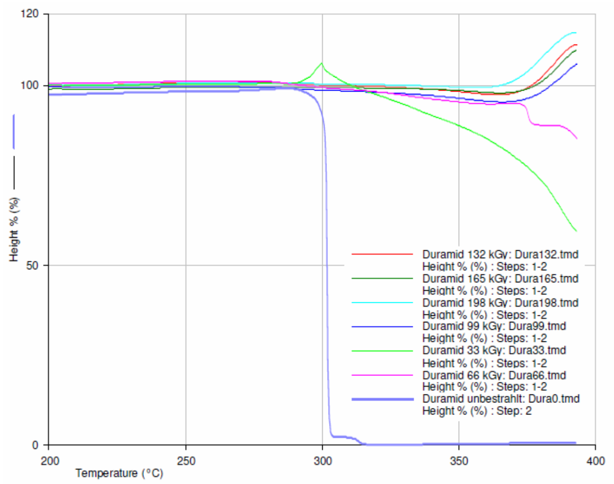

Fig. 5. **Temperature stability of PA**

Conclusion

Irradiation improves the thermal properties of polymer. All tested polymer (PE, PP and PA) show better temperature stability after irradiation. Irradiation significantly extends the application area of polymers. The service temperature can be higher than the melting point of not irradiated polymers.

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KL-09

OPTIMIZATION OF MIXING CONDITIONS FOR SILICA-REINFORCED NATURAL RUBBER COMPOUNDS

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Abstract

It is well accepted that mixing conditions are of paramount importance for the properties of silica-filled rubber compounds. The dump temperature and mixing interval between rubber, silica and silane coupling agent, prior to adding other ingredients for silica-filled natural rubber (NR) compounds using bis-triethoxysilylpropyl tetrasulfide (TESPT) as coupling agent were optimized. Mooney viscosity, cure characteristics, silica dispersion (as indicated by the reinforcement parameter, flocculation rate constant and Payne effect), loss tangent at 60 °C (indication of rolling resistance of tires) and mechanical properties: tensile strength, elongation at break, reinforcement index and tear resistance were investigated. The dump temperature is the key parameter governing the properties of the silica-filled NR compounds. The increase in viscosity of the compounds by changing the dump temperature from 100–150 °C indicates that inevitably some crosslinking occurs of NR by sulfur contained in TESPT, simultaneous with the silanization reaction between silica and silane. However, the viscosity decreases again when dump temperatures above 150 °C are applied, indicating a dominant occurrence of degradation of the NR molecules. The results are in good agreement with bound rubber contents. The overall properties

indicate that a dump temperature in the range of 135–150 °C and a silica-silane-rubber mixing interval of 1 0 minutes are the most appropriate mixing conditions for silica-filled NR compounds with TESPT as coupling agent.

KL-10
POLYMER SCIENCE IN SERVICE OF AUTOMOTIVE INDUSTRY

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Isotactic polypropylene (iPP) is one of the most important industrially used polymers (not only) for automotive applications. Today, each passenger car contains more than 60 kg of polypropylene based material. This fact is mainly arising from a variety of iPP modifications based on the molecular and supermolecular design, use of fillers, additives and nucleating agents or even on a blending with other polymers – these factors all together make from iPP the material interesting also scientifically, which favorably contributes in the increase of technical understanding. Such a relation is a closed loop in which developments of new applications can be based on a solid polymer science background. Several examples of these interrelations allowing a design and construction of engineering applications, such as innovative bumpers, fenders, seat carriers or air-intake-manifolds will be presented.

The structure property interrelations in PP can be gathered from the individual structural levels. On the supermolecular level, the variation between the crystalline and amorphous phases, resulting mainly from the material stereoregularity, can be first considered. In addition at this level (within the crystalline portion), iPP exhibits polymorphic behavior as it crystallizes into four different crystalline modifications, namely monoclinic α, trigonal β, orthorhombic γ and mesomorphic smectic forms[1]. The α-crystalline form is the most common and predominant in common iPP processed by standard conditions; to obtain higher amounts of β-form, the use of specific nucleation is essential – such material shows then favorably enhanced toughness and drawability as compared to common α-form iPP[2,3] and is used also industrially (see Beta (β)-PP™ BE60 in Ref.[4]). Coming from the supermolecular to the next structural level – spherulitic, where the lamellae are organized in complex aggregates, also here their size and organization can be influenced by several ways, eg. by using of nucleating agents or clarifiers. These help to fasten the crystallization (ie. processing) but also favorably adjust mechanical properties and even improve organoleptics by increased transparency: presently transparent iPP is an essential material related to the packaging (and other) industry, see eg. Ref.[5]. Another structural level is created by morphology being created by crystallization of two or more mutually immiscible materials where individual phases creates a system of two (or more) separated morphologies. Typical example is the iPP material called heterophasic or impact copolymer having the iPP matrix while the softer inclusions are based on ethylene-propylene copolymer; impact strength even at low temperature is significantly enhanced[6]. Such material is a key material for automotive applications. Its subsequent modification with other components like external rubber, fillers and other additives creates another structural level encompassing the morphology of the base material with the relation to other individual components; see the example in Fig. 1, top. Interfaces between them play then a critical role when adjusting material properties to a given application, see eg. a fender application in Fig. 1, bottom left. Another example is the iPP based composite filled with glass fibers – here the use of appropriate compatibilizer in a given concentration must guarantee a proper interface between the glass fiber and the polymer resulting in a large enhancement of the material stiffness but yet taking into account to keep rather high impact strength. As a consequence, such compounds move iPP from the field of commodity polymeric materials into full-value member of the engineering plastic material pool next to polyamides, polyesters and others. Consequently, resulting applications can range from structural carriers and covers, fan shrouds, front-end and seats carriers up to motor parts like air intake manifold[7], see Fig. 1 bottom right – offering better technical functionality (optimized air flow), design freedom (integration of functions), reduction in weight and at the end also lower costs. The knowledge of all the interrelations briefly mentioned above are critical when developing improved iPP based materials for demanding automotive applications.

Fig. 1. ***Top*: electron microscopy micrograph of the morphology of heterophasic mineral filled PP after RUO4 staining; *Bottom left*: Fender Application for BMW X5 (mineral filled iPP compound Daplen™ EF341AE); *Bottom right*: Air Intake Manifold (glass-fibre filled iPP compound XMOD™ GB306SAF)**

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