Abstract

The systematic development of next generation advanced engineering plastics compounds for structural applications requires materials science and micromechanics based modeling and simulation tools along with an improved understanding of the complex interaction between constituent properties, constituent geometry or phase structure, constituent content and distribution (i.e., microscopic material level) and compound properties and material laws (i.e., macroscopic material level). Hence, the main objective of this study is to develop and verify a simulation methodology using the DigiMat® (eXstream engineering, Foetz, LX) software tool for heterogeneous polypropylene compounds.

While fibers and mineral particles are frequently used to enhance the stiffness of polymeric materials, rubber particles are applied to improve the toughness in e.g. automotive applications. In the first part of the study **2 phase PP model compounds** were investigated. First hard particle (minerals) filled PP compounds and the elastic properties of the constituents (PP matrix and mineral particles) were determined over a wide testing rate and test temperature range and micromechanical simulations were carried out under both strain controlled monotonic tensile loading conditions and under stress controlled creep loading conditions over a wide test temperature range. While for monotonic loading the relevant parameters were tensile modulus values, for creep loading, creep modulus values were measured, master curves constructed and transformed into an adequate material model (Prony series). Furthermore, rubber particle filled PP compounds were produced and investigated in the same manner. Moreover, a polymer fiber type revealing time dependent viscoelastic behaviour was embedded in the PP matrix and both monotonic and creep loading was applied. Special emphasis was given from the material characterization point of view to the determination of accurate elastic modulus values of the fibres and the consideration of the time dependent behaviour.

In the second part of the study a **3 phase model system** including PP matrix, a hard and a soft phase have been investigated. In addition to the above described material complexity, 3 main structure configurations were studied; hard particles either located in PP matrix or in the rubber phase or are evenly distributed in both phases. The results are shown in terms of particle arrangement dependent modulus values. Finally, as real application type materials (i.e. automotive) are again more complex and consist of more than 3 phases, a **4 phase PP real compound** was also investigated and the first preliminary results are discussed in terms of tensile modulus values for monotonic loading conditions.