Short fibre-reinforced polymers – from experiments to a 3D model

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The contribution presents the experimental characterization of a composite material, namely a polybutylene terephthalate (PBT) reinforced by short glass fibres. Different experiments are performed on specimens with different fibre content and with different fibre orientation. The experiments show that elasto-plasticity and damage dominate the material behaviour. With increasing fibre content stiffness and strength increase while the ductility of the specimens decreases. For the evaluation of the experiments the complete strain information in all directions is obtained by an optical area analysis over the whole surface using a digital image correlation (DIC) software [1]. The optical system uses four cameras to realize a 360°-3D-measurement by a two-sided stereography, which allows also for a thickness measurement. As a verification experiment a deep-drawing based testing device, a Nakajima test for polymeric materials is presented and first results of the experimental investigations are shown.

Finally a one-dimensional model is prestented which describes the observed effects. The model explicitly includes the fibre content. While the matrix material is assumed to be elasto-plastic, the fibres are characterised as purely elastic. Damage in form of fibre breakage and debonding are also included. First ideas for the expansion of the one-dimensional modeling description to the three-dimensional case by means of a microplane approach [2] is presented for further research.

[1] M.A. Sutton, J.J. Orteu and H. Schreier, Image correlation for shape, motion and deformation measurements (Springer Science & Business Media 2009).
[2] I. Carrol and Z. P. Bazant, Damage and plasticity in microplane theory. International Journal of Solids and Structures, 34(29), 3807-3835, (1997)