MECHANICS AND FAILURE IN THIN MATERIAL LAYERS TOWARDS REALISTIC PACKAGE OPENING SIMULATIONS

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Abstract

The final goal of this PhD-work is an efficient and user-friendly finite element modelling strategy targeting an industrial available package opening application. In order to reach this goal, different experimental mechanical and fracture mechanical tests were continuously refined to characterize the studied materials. Furthermore, the governing deformation mechanisms and mechanical properties involved in the opening sequence were quantified with full field experimental techniques to extract the intrinsic material response. An identification process to calibrate the material model parameters with inverse modelling analysis is proposed. Constitutive models, based on the experimental results for the two continuum materials, aluminium and polymer materials, and how to address the progressive damage modelling have been concerned in this work. The results and methods considered are general and can be applied in other industries where polymer and metal material are present.

This work has shown that it is possible to select constitutive material models in conjunction with continuum material damage models, adequately predicting the mechanical behaviour in thin laminated packaging materials. Finally, with a slight modification of already available techniques and functionalities in a commercial general-purpose finite element software, it was possible to build a simulation model replicating the physical behaviour of an opening device. A comparison of the results between the experimental opening and the virtual opening model showed a good correlation.

The advantage with the developed modelling approach is that it is possible to modify the material composition of the laminate. Individual material layers can be altered, and the mechanical properties, thickness or geometrical shape can be changed. Furthermore, the model is flexible and a new opening design with a different geometry and load case can easily be implemented and changed in the simulation model. Therefore, this type of simulation model is prepared to simulate sustainable materials in packages and will be a useful tool for decision support early in the concept selection in technology and development projects.

Keywords: aluminium foil, FEM, LDPE, localisation, necking, polymer, progressive damage, semi-crystalline, simulation, virtual twin