Failure Modeling of Unreinforced and Fiber reinforced Thermoplastics

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1 Introduction

In the last years the demands of the automotive industry have led to a strong interest in a more detailed virtual description of the material behavior of thermoplastics. More and more complex material models, including damage and failure, have to be characterized, while keeping the importance of gaining material data quickly in mind.
Currently material and failure modeling in crash simulations typically deal with simple von Mises visco-plasticity (***MAT_024**) and equivalent strain failure criteria, which cannot describe the complex material behavior of plastics. Past developments have focused on the yield behavior under different load situations (tension, shear, compression), which are implemented in more complex material models like ***MAT_SAMP-1** for thermoplastics as well as ***MAT_215** for fiber reinforced thermoplastics.

2 Research on failure behavior with IMPETUS™

In the last years 4a developed different testing setups to investigate failure behavior for thermoplastic materials. Especially the linked highspeed camera helps to detect the first failure in puncture tests as well as supports to conduct DIC (digital image correlation) during tests like in the shown dynamic tensile test using the testing device IMPETUS™. Current results for PP T10 as well as for PP GF30 are shown.

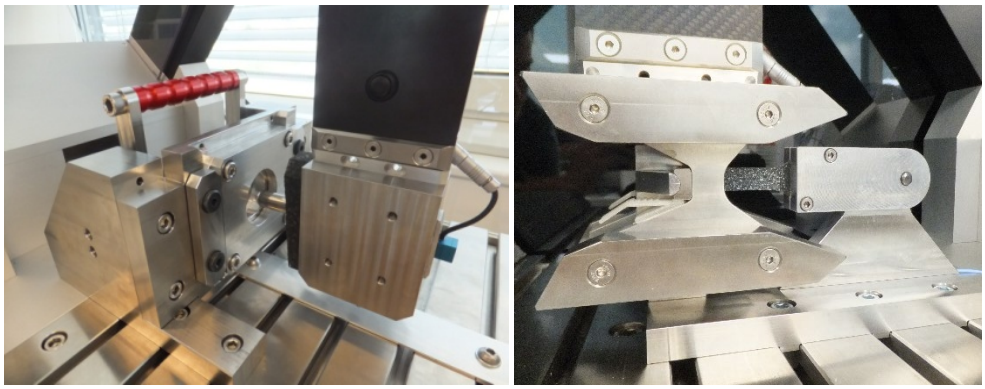

Fig.1: left – puncture test, right – new test method in IMPETUS™: dynamic tensile test

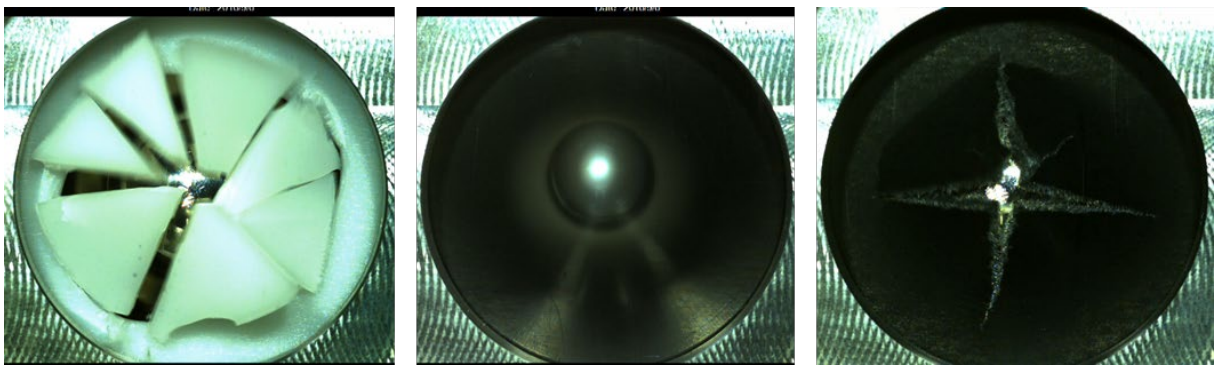

Fig.2: different failure modes: left – POM (brittle), middle- PC/PET (ductile), right – PPLGF30

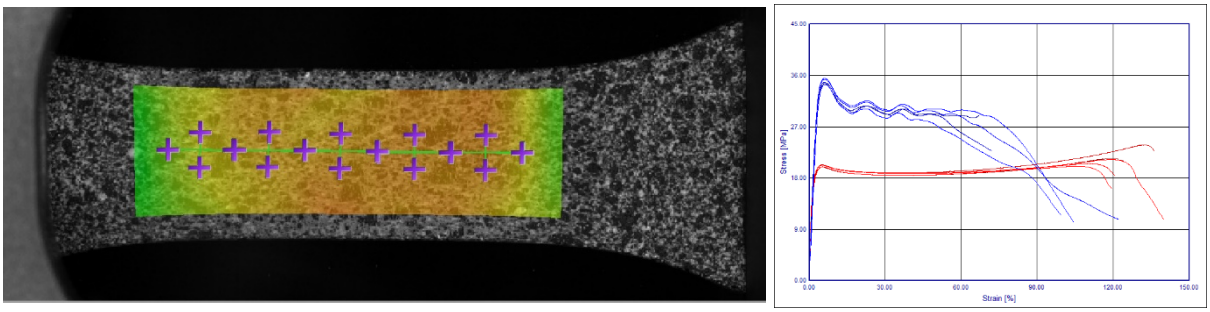

Fig.3: PPT10: left - DIC strain measurement before rupture (~70% true strain), right – true stress/strain comparison for static (1 mm/s) and IMPETUS™ dynamic tensile test (3 m/s)

3 Material modeling

Based on the conducted tests, different approaches to describe material behaviors especially damage and failure are presented. Current available LS-DYNA® failure models - ****MAT_SAMP-1*** directly versus ****MAT_ADD_EROSION (GISSMO or DIEM)*** - are compared to each other, focusing on restrictions and possibilities of the models, to describe the measured material behavior. To gain quick access to these material cards, the mentioned material models as well as the simulation models of the conducted tests are implemented in VALIMAT™. With the support of LS-Opt® VALIMAT™ provides an almost automatic workflow to identify the necessary material parameters in the material cards.

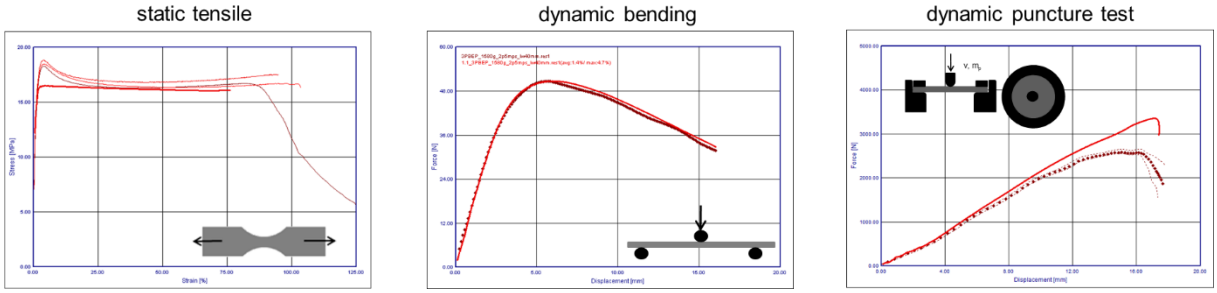

*Fig.4: PP-T10 material modelling with ***MAT_SAMP-1***

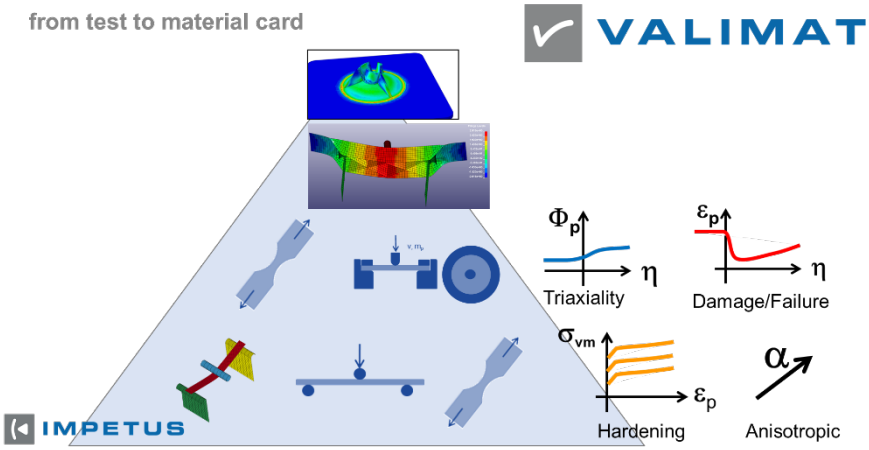

Fig.5: Characterization pyramid for IMPETUS™; from basic characterization up to final component validation.