1. Introduction

Technical Committee 4 on Fracture of Polymers, Composites and Adhesives of the European Structural Integrity Society (ESIS) has been active in the development of fracture mechanics test methods for polymers, composites and adhesives for more than 25 years. Typically the development is pursued via round robin tests on a range of materials performed at several laboratories. Testing is followed by extensive data analysis and adaptation of the test procedure, if necessary, in order to achieve consistent and sufficiently reproducible results. An important issue is the use of the data generated by the application of the test procedures. Comparative materials characterization, e.g., for quality control, or determination of values for data sheets are relatively straightforward. Using fracture mechanics data for design of structures, on the other hand, requires detailed analysis and interpretation. Test development is emphasizing applicability of the test procedure in an industrial test environment. However, during round robin testing, sometimes high-tech equipment and measurement techniques are employed for achieving a sufficient understanding of fracture processes and the parameters affecting them. This has resulted in a number of International Standards for fracture testing (e.g., ISO 13586, ISO 15024, ISO 15850).

2. Experimental Results

Current activities of ESIS TC4 deal with essential work of fracture testing for polymer films or thin plates, with $J_c$ and peel testing of polymers and testing of structural adhesives. Most recent activities include cutting and scratching and environmental stress cracking. One of the most successful activities, however, was related to the determination of $K_I/G_I$ values for polymers at 1 m/s and at higher loading rates. A novel methodology for moderate loading rates (up to 1 m/s) was elaborated and summarized in an ISO standard (ISO 17281). A typical load-displacement curve of a notched bending specimen (SENB) is shown in Fig. 1.

![Fig. 1: Load-time curve of SENB specimen for PVC at 1 m/s loading rate.](image-url)

Furthermore, impact test have been performed at higher loading rates (up to 20 m/s) and the applicability of dynamic methods was investigated. The testing rate dependence of time-to-fracture values for an SENB specimen is shown in Fig. 2.

Composites activities include fracture and delamination resistance of short fibre and continuous fibre composites under quasi-static, high-rate or cyclic fatigue loading, respectively and fracture of nanocomposites.
The applicability of ISO standard 13586 for silicate-epoxy nanocomposites is currently investigated in a round robin test series involving five laboratories. Preliminary results from one laboratory (Figure 3) indicate that the fracture toughness and the energy release rate are improved by the addition of a few weight percent silicate nano-filler. Scatter in the data can be evaluated, once all results are available. Quasi-static test procedures for delamination resistance of continuous fibre-composites (e.g. ISO 15024, ISO/CD 15114) are adapted for investigating the cyclic fatigue behaviour of laminates. Preliminary results for one type of carbon-fibre reinforced epoxy laminate (Figure 4) indicate that these draft procedures look feasible and that consistent results can be obtained. Typically, mode I loading yields lower delamination resistance than mode II. For cyclic fatigue testing, the question of threshold behaviour of composites will also be discussed, since it is of relevance for the design of structures.

The data presented here were generated in diverse round robin tests by ESIS TC 4 members.

3. Acknowledgements

4. References


