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Editorial corner – a personal view
Challenge with the scatter in ductile to brittle transition fracture transition of polymers

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It is well known that the mechanical behaviour of a plastic component is determined by several factors like deformation rate, material composition, design, processing, and service conditions. Many commercially significant polymers exhibit abrupt changes in fracture behavior from ductile to brittle – or vice versa – over relatively narrow intervals of test or structural variables. The discontinuous transition from unstable to stable crack propagation has been described as 'brittle to ductile transition'. Conversely, within the ductile-to-brittle region materials display mixed ductile and brittle behaviour. This pattern is characterized by a broad distribution of failure energies. The scatter does not arise from differences in specimen preparation or in testing procedures, but because both brittle and ductile failure micromechanisms occur simultaneously. Consequently, plastic parts exhibit a random spatial fluctuation of material toughness characteristics. Although plenty of research has been devoted into trying to understand the role of the different parameters contributing to this phenomenon, a consistent fundamental model in which to base the interpretation of empirical data regarding this transition is still absent. The inherent scatter in toughness values displayed by polymers within ductile-brittle transition has been rarely reported on in the specific literature nor has it been taken into account in fracture mechanics determinations. Assuming that the fracture resistance can be measured in terms of a single critical parameter, this problem is not amenable to a conventional linear and non-linear fracture mechanics analysis. When scatter is considered, a single average toughness parameter fails to describe properly the experimental results. Nowadays, new methodologies and strategies, based on micromechanical analysis of materials, have been developed. They have demonstrated to be of use in characterizing and interpreting the inherent scatter of fracture energy values in other engineering materials which show a similar phenomenon. These approaches require to know the full micromechanisms acting during crack propagation and the modifications in the stress field ahead of a propagating crack. This type of knowledge in the field of integral structural of polymer parts is still incipient. It is my belief that such investigations will contribute to understand and model ductile to brittle fracture transition in plastics, and to give insight into the difficult problem of transferring laboratory results to real applications. Therefore, new plastic parts with improved fracture performance and enhanced reliability can be produced in the near future.

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