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EXTRACTING RATE-DEPENDENT TRACTION-SEPARATION RELATIONS FOR CRACKS/INTERFACES IN VISCOELASTIC MEDIA

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Methods for characterizing and predicting crack growth in linearly or non-linearly elastic materials are well established both theoretically and experimentally. However, fundamental work relating to fracture in polymers and other time dependent materials is relatively limited. The primary objective of this study was to establish a theoretical framework for developing a simple experimental procedure aimed at quantifying traction separation relations, a vital fracture parameter for cohesive interfaces in viscoelastic media. In this paper, development of a modified J-integral approach, a formulation similar to the pseudo J-integral developed by Schapery, with the purpose of maintaining the path independence property characteristic of the J-integral, will be presented in detail. Furthermore, the development of a modified field projection method (MFPM), which will be used to assist in extracting the functional form of tractions at any given time along the interface, will be presented along with a discussion as to why such a formulation is warranted while applying the modified J-integral approach to extract the rate dependent traction-separation relations.

Numerical and physical experiments were carried out on two strips of polyvinyl acetate, a polymer known to exhibit a quantifiable amount of healing, which were brought into contact for a range of healing times and then separated in a classical fracture mechanics test; the clamped strip with a semi-infinite crack. To further articulate, the uniform healing promoted along the interface in the specimen was represented in terms of rate dependent traction-separation relations, which were in turn quantified using MFPM and the modified J- integral approach. Digital image correlation was used to measure the displacement field within the specimen and the finite element software ABAQUS was used to further assist in the process of extracting the rate dependent traction-separation relations. Results from both numerical and physical experiments will be presented and demonstrated to support of this new framework and current limitations along with scope for future work will be discussed.