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DETERMINATION AND MODELIZATION OF MODE I INTERLAMINAR FRACTURE THOUGHNESS ON 2D WOVEN OXIDE/OXIDE COMPOSITE USING DOUBLE CANTILEVER BEAM TEST

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ABSTRACT

Ceramic Matrix Composites are light materials with excellent mechanical properties at high temperature, which make them potential candidates for such industrial applications. Specifically, laminated Oxide/Oxide CMCs are relevant for moderate thermo-mechanical loadings because of the advantageous trade-off between their mechanical properties and their cost. For such laminated composite materials, study the initiation and propagation of delamination between plies remains a key point in order to perform relevant designs of industrial composite structures. Nevertheless, the characterization of the initiation and propagation of delamination in Oxide/Oxide composites are, to the author's knowledge, not much studied in the literature. Therefore, this study focuses on the characterization and modelling of the delamination propagation in mode I for 2D woven Oxide/Oxide ceramic matrix composites.

Firstly, an experimental part aimed at characterizing the delamination fracture toughness in mode I GIC using double cantilever beam (DCB) tests, as reported in Figure 1is presented. Such a test allows to determine the parameters of the delamination propagation criteria in pure propagation mode I. Procedures and methodology are derived from studies carried out on polymer matrix composites [1], but some specificities must be considered with CMC materials. Two methods of pre-cracking are compared. The first one consists in inserting a Teflon microfilm between two plies as the ply layup is elaborated (ASTM D5528 [2]). The second one consists in making notch using a wire saw in already manufactured specimens. Although more difficult, this second method can be applied to any part without a special manufacturing process. In both cases, after pre-initiation of the crack, delamination propagation is measured optically using a camera. This procedure agrees with the test and calculation methods presented in the ISO 15024 standard, which makes it possible to measure the toughness of the interface but also to determine the R-curve [3].

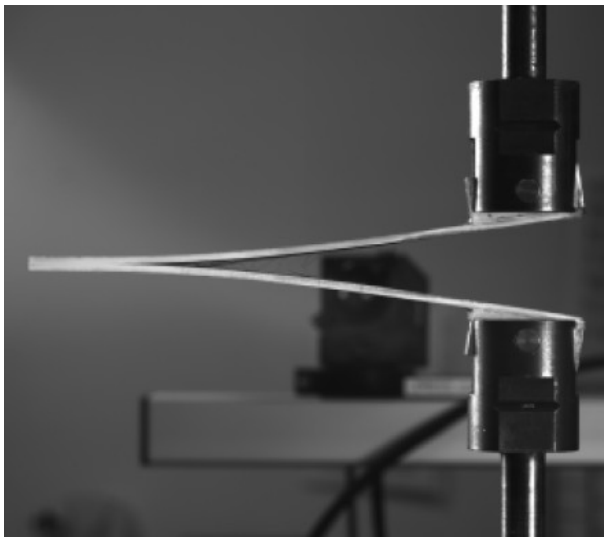

Figure 1 : DCB test setup [4]

Secondly, fracture toughness obtained is compared with simulations carried out using finite element software Z-Set with an implicit solver. Cohesive zone elements (CZ) are considered to model the delamination behaviour. Based on previous works on polymer matrix composite (PMC) [1], several expressions of cohesive zone model (CZM) will be evaluated and discussed considering the available. The comparison between the results of experimental measurement and those obtained using the finite element model are presented. The relevance of the model initially designed for PMC and apply to CMC is discussed. Finally, delamination tests in mode II such as for example ENF tests (End Notched Flexure) and mixed mode I/II with MMB (Mixed-Mode Bending) tests could be considered.

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