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Interface toughening in multilayered systems through extrinsic plastically deforming or compliant dissipative interlayers

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The thermomechanical integrity of all types of multilayers, bonded joints or laminates is primarily controlled by the adherence between layers. The natural way to improve adherence is by improving the physico-chemical or mechanical adhesion or by working on the intrinsic toughness of the adhesive/glue used to join layers. But, sometimes, the intrinsic interface toughness is limited by processing, chemical or physical difficulties. In such circumstances, different extrinsic solutions are available to increase the energy dissipated during crack propagation. A first option is to play with the plastic dissipation inside the adhesive joint. Here, we will describe the results of a recent study showing the importance of the softening effect inside polymer adhesives on the fracture resistance, combined with the effect of adhesive thickness [1]. A second option is by inserting an extra layer inside the stack, with the purpose to dissipate additional energy and/or to reduce the intensity of the loading on the interface undergoing failure. This second approach will be illustrated by an idealized example taken from the molecular bonding field [2], and by a recent study dealing with cracking along an interface between a ductile thin film and an elastic substrate [3] involving a compliant interlayer. In all these examples, the model is based on an asymptotic *K*-field formulation relying on cohesive zone elements to simulate the fracture process. The predictions are assessed towards experimental results. These findings, combined to other options found in the literature that will be mentioned, can guide the development of more systematic design rules for delamination resistant multilayers. They also provide a critical assessment of experimental protocols for interface toughness measurements requiring the bonding of a dummy substrate, such as DCB or four points bending.

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