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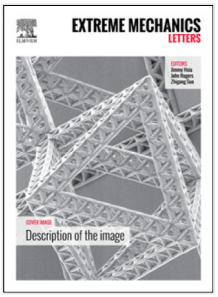

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Miniaturized Fracture Experiments to Determine the Toughness of Individual Films in a Multilayer System

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Abstract

Recently, the miniaturization of devices in the field of microelectronics has become more and more important. This also implies an increased complexity of the devices, where multilayer thin film systems play a major role. The use of various material combinations leads to the development of residual stresses, potentially causing cracks. Therefore, to prevent failures a thorough understanding of material properties such as the fracture toughness at small scales is indispensable, as these may differ significantly from bulk values. In this study we use miniaturized fracture tests to investigate the fracture behaviour of Cu-W-Cu and W-Cu-W trilayer thin film systems, having a thickness of 500 nm per individual W or Cu layer. The films are subjected to differences in elastic properties and residual stress gradients that both influence the fracture behaviour and thus have to be included in all considerations. We demonstrate that for the W layers a valid *J*-integral can be evaluated. However, we find that the presented advanced treatment does not allow the extraction of valid fracture mechanical quantities for the Cu layers, pointing out the need to develop a more sophisticated approach for ductile materials.