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Effects of Interfacial Topography on Fracture at the Nanoscale

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Interfaces are defined by composition, structure and the nature of bonding at the atomic scale, and by the variations in substrate surface topology at larger scales. However, limitations in test capabilities have limited direct measure of topology effects on adhesion of thin films at the nanoscale. We therefore began a program to define how small variations in topography affect interfacial fracture using film fracture tests and finite element analysis. For this work, tungsten films were deposited onto smooth silicon substrates for reference and onto nanopatterned silicon substrates to assess effects of topology. Residual compressive film stresses triggered buckling from which fracture energies were determined. In this presentation, we will use the test results and finite element simulations to show how small-scale variations in topography affect resistance to fracture thus providing a means to tailor nanoscale film device performance. This work was supported by Sandia National Laboratories under USDOE grant DE-AC04-94AL85000.