Adhesion and Fracture in Thin Films and Devices

Abstract:

Nanostructured materials are the basis for many emerging technologies, such as MEMS, NEMS and small scale electronics, that will dominate near term advances in nanotechnology. These technologies are often based on devices containing layers of metal and ceramic films, and interconnects creating surfaces and interfaces with properties and responses that differ dramatically from bulk counterparts. The differing properties can lead to delamination and buckling in compression and film fracture and decohesion in tension, resulting in device failure. Bulk material behavior cannot be simply extrapolated to the nanoscale. Moreover, severe limitations are imposed by test methods that are difficult or impossible to apply at the smallest size scales. As a result, the relationships between composition, structure and properties, and especially adhesion and fracture, are not well defined. These relationships are critical to assuring performance and reliability of nanostructured materials and devices. For example, tantalum nitride films are used extensively in microelectronic applications. Gold films are of special interest where the need to minimize stress effects requires deposition of very thin films. And tailored oxides are often used to provide surface and wear protection. In all these systems, adhesion and fracture control performance and reliability. In this presentation we will review our use of nanomechanics and nanoindentation techniques to measure fracture properties and define processes controlling adhesion and fracture in microelectronic films and interconnects.

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