MECHANICAL PROPERTIES OF NANOSCALE ORGANOSILICATE THIN FILMS AND STRUCTURES

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Abstract

Hybrid organic-inorganic glasses exhibit unique electro-optical properties along with excellent thermal stability, and therefore, this class of materials has attracted considerable interest in materials science and engineering. However, their fragile nature remains a fundamental challenge for their integration in advanced products. This talk focuses on the mechanical properties of nanoporous organosilicate glasses (OSGs), including elastic modulus and fracture toughness, but also cohesive and adhesive failure in thin film stacks. We demonstrate that novel synthesis approaches to manufacture nanoporous materials with optimized topology, particularly self-assembly processes, are able to control pore size and pore topology. Particularly, elastic modulus values close to the Hashin-Shtrikman upper bound can be reached for thin films with periodically arranged pore structures with constant pore size.

Double cantilever beam (DCB) testing provides the energy release rate of thin films. In addition, in-situ micro-DCB tests in an X-ray microscope allow to image crack propagation processes with sub-100nm resolution. Nanoindentation experiments are usually used to measure the elastic modulus of thin films, however, this technique is able to provide fracture toughness information as well. A wedge-shape indenter is used to delaminate ULK films locally. The fracture energy associated with the indentation induced delamination is evaluated considering the pore densification process.

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