Modeling Interfacial Fracture

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The talk will give an introduction to some basic concepts in Fracture mechanics. Materials that are fractured, no matter how small the fracture, act much differently than the same material without cracks. So it is of utmost importance to be able to understand and predict the behavior of a crack. Fracture mechanics is an area in solid mechanics that tries to explain under what conditions a crack begins, and how it grows.

The analysis of several fracture models based on a new approach to modeling brittle fracture will be presented. The considered modeling approach incorporates important nanoscale effects near the fracture surfaces into a continuum modeling framework. I will discuss the effects of ascribing constant and curvature-dependent surface tension to the fracture surfaces.

In the case of the classical Griffith crack (a crack of finite length in a single linearly elastic material, subjected to far filed tensile loading) we show that the proposed model leads to a cusp-like crack opening profile at the crack tip, in contrast to the blunt profile predicted by the classical theory of brittle fracture. Moreover, such models yield bounded stresses and strains. In particular, they do not suffer from the internal inconsistencies, characteristic of Linear Elastic Fracture Mechanics (LEFM), which is based on the assumption of small stresses and strains, but predicts singular stresses and strains in a neighborhood of a crack tip.

Further, the problem of interface fracture will be discussed briefly. Within the studied modeling approach, it leads to a system of four coupled singular integral equations, with a Cauchy-type singularity, which can be reduced to a four by four system of Fredholm integral equations of the second kind. We will discuss the implications of ascribing surface excess properties to the bimaterial interfaces.

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