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A two-scale approach for the issue of crack nucleation in fracture mechanics

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It is well-accepted that Griffith-like models are appropriate for crack propagation at the scale of a structure, but inadequate for the modeling of crack nucleation in brittle materials. Arguably, finer models, where a microscopic (material) length scale plays a fundamental role, are necessary to determine the critical load and crack geometry at the onset. The consistent combined modeling and numerical simulation of crack nucleation and propagation from the material to the structural length-scale is a challenging and largely open issue.
In this talk we will consider gradient damage models and cohesive force models which contain both the concepts of critical stress and fracture energy and hence are good candidate to include in a unique setting the issues of nucleation and propagation of cracks. By considering fundamental problems as those of a thermal shock or of a notched body, we will show in particular that the nucleation of cracks predicted by such models is in fact an instability process. Theoretical arguments coupled with numerical tests will support this claim.

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