NON-LINEAR SCALING IN MATERIAL FAILURE

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ABSTRACT

Most engineering structures are not designed to include macroscopic cracks, and in the absence of such flaws, Griffith's theory predicts an unrealistic, infinite load-bearing capacity. This discrepancy has led to the predominant use of stress-based criteria in design standards. However, experimental studies [1] have shown that materials adhere to stress-based predictions only for small samples, while larger samples or those with cracks conform to Griffith's theory. Between these extremes exists a nonlinear regime, characterized by a critical length scale, where neither theory accurately predicts failure behavior. It is within this region that many manufacturing defects and real-world failures occur.

This symposium will explore techniques and examples where these nonlinear effects are significant, provide guidelines for addressing them, demonstrate how to measure this critical length scale in realistic materials and suggest methods to use it in designing innovative materials.

The symposium seeks to foster a close exchange between disciplines, particularly by integrating physics and mechanics, facilitating discussions that bridge experiments and simulations. Presentations are invited on a wide range of theoretical, numerical, and experimental investigations into the microscopic origins and macroscopic effects of emerging length scales in both quasi-static and dynamic cases. The diverse topics of interest include:

- Various phenomena such as localized plasticity, shear banding, crack initiation and propagation, nucleation and void growth.

- Processes like initiation, re-initiation, propagation, or arrest of cracks and defects.

- Numerical and theoretical approaches, including coupled criteria, phase-field models, cohesive zone theories, atomic-scale simulations, thick level sets, discrete element methods, crack band theories, and other hybrid techniques.

- Experimental techniques related to fracture such as, for instance, high-speed imaging, micro-CT scanning, in-situ measurements, full-field measurements or acoustic emission.

- Challenges related to interface cracking, delamination, additively manufactured and composite materials, small-scale testing.

[1] R. G. Irwin. *Fracture*, Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 551–590, 1958.