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STRENGTH AND TOUGHNESS IN MATERIAL FAILURE

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ABSTRACT

The symposium is dedicated to understanding the relationship between strength and toughness in material failure. While engineering design has traditionally relied on strength-based approaches, fracture mechanics has highlighted the importance of toughness in determining structural integrity. Connecting these two perspectives remains a fundamental challenge, particularly for materials containing defects, heterogeneities, or evolving damage.

The symposium will explore experimental, theoretical, and computational approaches that link strength and toughness across materials and scales. Emphasis will be placed on the mechanisms governing this relationship, methods for characterizing both properties, and their application to the design of safer and more damage-tolerant materials and structures. Contributions are invited on topics including:

- Damage mechanisms, crack initiation, and crack propagation.
- The role of microcracking, defect interactions, and fracture process zones in fracture.
- Transitions between strength-controlled and toughness-controlled failure.
- Experimental methods for measuring strength, toughness, and fracture processes.
- Numerical and theoretical approaches, including coupled criterion, finite fracture mechanics, phase-field and cohesive zone models, discrete methods.
- Fracture challenges in interfaces, composites, additively manufactured materials, architected materials, and small-scale testing.
- Material and structural design strategies that exploit the correlation between strength and toughness.

By bringing together researchers from physics, materials science, mathematics, and mechanics, the symposium aims to advance a unified understanding of how strength and toughness govern material failure and how this knowledge can be translated into engineering practice.