Multiscale modeling of size effects in the fracture of soft solids

Ph.D. Position *[1]

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Start Date: April 2020 – October 2020

Research Area: Computational Mechanics/ Computational Soft Matter Physics

Required Prerequisites: Applicant should have a solid background in:

- solid mechanics with a special emphasis on continuum mechanics
- computatoinal mechanics
- ideally C++ programming skills

PROJECT OUTLINE

Owing to its scale-spanning nature from individual monomers to complex polymer networks, fracture in soft materials vastly differs from classical theories and requires accounting for the effects of nonlinearity, irreversibility, nonlocality and possibly multiple phases. As one consequence, strong size effects have recently been observed in the fracture of soft solids when descending to small scales. Experiments have indicated a transition in failure mechanisms and in the geometry of failure process zones, when decreasing the crack size below a characteristic length scale. The causal mechanisms – and, more generally, a fundamental understanding of fracture in soft solids across length scales – have remained widely unexplored but are key to fully exploiting novel classes of soft materials. The **objective** of this Ph.D. project is to establish new full-physics theory and associated numerical tools for a complete fundamental understanding of fracture in soft solids across length scales. This will be achieved through a bottom-up multiscale approach, taking crosslinked silicone elastomers as a model system.

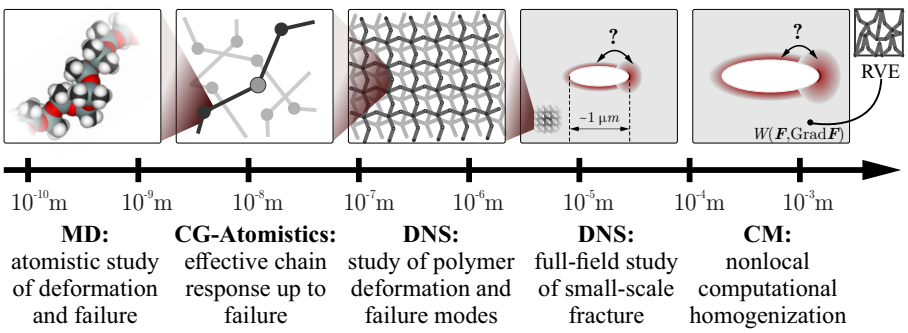

Figure 1: Hierarchy of methods to be employed in elucidating the transitional behavior of fracture in soft solids: Molecular dynamics (MD) studies are passed to the level of Discrete Numerical Simulations (DNS) via Coarse- Grained (CG) Atomistics. Finally, Continuum Mechanics (CM) uses nonlocal homogenization at larger scales.

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