Effect of topological disorder on the toughness of spring networks

Antoine Sanner*[1], Alessandra Lingua[1], Luca Michel[1], and David S. Kammer[1]

[1]Institute for Building Materials, ETH Zurich – Switzerland

Abstract

On a coarse-grained level, polymer gels and architected materials correspond to a network of (nonlinear) springs. Here, we investigate how topological disorder affects crack propagation in spring network simulations. In particular, we quantify the fracture energy, or toughness, that corresponds to the energy dissipated per unit crack advance. Our simulations show that the heterogeneity introduced by randomly removing springs pins and deflects the crack, leading to an increase in fracture energy. The crack paths are different depending on the critical strain of the springs. While for a critical spring strain of 1, the crack path remains nearly planar, for a critical strain of 0.1, additional springs break away from the main crack plane, i.e. damage is diffuse. We explore possible links between this diffuse failure and rigidity percolation.

*Speaker