Examining fracture behavior in heterogenous poro-elastic media from nano to macro-scale

Pania Newell
The University of Utah

Many materials surrounding us from man-made materials such as cement, concrete, and ceramics to natural materials such as biological tissue, rocks, and soil are considered as porous materials. Due to their unique properties, such as light weight, heat resistance, sound absorption, thermal conductivity, electrical resistivity, porous materials are appealing to various engineering and scientific applications. Many porous materials can be classified as elastic quasi-brittle materials, where the global failure is associated with brittle damage spread across the pore network and other flaws and discontinuities in the media. However, understanding damage and fracture in these materials present unique challenges due to their heterogenous microstructure spanning across the scales. This talk will address how computational tools enable us to enhance our fundamental understanding of fracture propagation mechanisms in such materials across multiple scales. At nanoscale, molecular dynamics simulation provides information about mechanical properties, such as fracture energy release rate for various pore morphology. At microscale, the impact of the pore shape and size on fracture pattern is investigated through a two-scale homogenization method coupled with the state-of-the-art phase-field fracture technique. The results of this hierarchical coupling approach highlight the importance of higher-order parameters associated with pore shape and size on fracture strength and pattern at continuum scale.