Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

Failure of brittle heterogeneous materials: intermittency, crackling, and seismicity

Bares, Jonathan, jb427@phy.duke.edu, Duke University, United States; Bonamy, Daniel, CEA, Saclay, France; Dalmas, Davy, UMR CNRS-St Gobain, France

ABSTRACT

The problem of the solid fracture is classically addressed within the framework of continuum mechanics. Still, stress enhancement at crack tips makes the failure behavior observed at the continuum-level scale extremely dependent on the presence of microstructural inhomogeneities. This yields statistical aspects which, by essence, cannot be addressed using the conventional engineering continuum approaches. We designed an experimental setup that allows growing well-controlled tensile cracks in brittle heterogeneous solids of tunable microstructure, over a wide range of loading speed. The crack dynamics and the evolution of stored and released mechanical energy are monitored in real time. In parallel, the acoustic emission is recorded via a series of acoustic transducers and analyzed in a way similar to that develop by geophysicists to process seismic signals. These experiments allowed us to characterize quantitatively the crackling dynamics of cracks, also to evidence intriguing statistical similarities between the seismicity associated with this simple situation (single crack under tension) and the much more complex situation of multicracking in compressive fracture and in earthquakes.