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2009 J. Phys. D: Appl. Phys. 42 210301

(http://iopscience.iop.org/0022-3727/42/21/210301)

J. Phys. D: Appl. Phys. **42** (2009) 210301 (1pp) doi:10.1088/0022-3727/42/21/210301

EDITORIAL

Fracture: from the atomic to the geophysical scale

Guest Editors

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Although fracture is a very common experience in every day life, it still harbours many unanswered questions.

New avenues of investigation arise concerning the basic mechanisms leading to deformation and failure in heterogeneous materials, particularly in non-metals. The processes involved are even more complex when plasticity, thermal fluctuations or chemical interactions between the material and its environment introduce a specific time scale. Sub-critical failure, which may be reached at unexpectedly low loads, is particularly important for silicate glasses.

Another source of complications originates from dynamic fracture, when loading rates become so high that the acoustic waves produced by the crack interact with the material heterogeneities, in turn producing new waves that modify the propagation.

Recent progress in experimental techniques, allowing one to test and probe materials at sufficiently small length or time scales or in three dimensions, has led to a quantitative understanding of the physical processes involved. In parallel, simulations have also progressed, by extending the time and length scales they are able to reach, and thus attaining experimentally accessible conditions.

However, one central question remains the inclusion of these basic mechanisms into a statistical description. This is not an easy task, mostly because of the strong stress gradients present at the tip of a crack, and because the averaging of fracture properties over a heterogeneous material, containing more or less brittle phases, requires rare event statistics. Substantial progress has been made in models and simulations based on accurate experiments. From these models, scaling laws have been derived, linking the behaviour at a micro- or even nano-scale to the macroscopic and even to geophysical scales.

The reviews in this Cluster Issue of *Journal of Physics D: Applied Physics* cover several of these important topics, including the physical processes in fracture mechanisms, the sub-critical failure issue, the dynamical fracture propagation, and the scaling laws from the micro- to the geophysical scales. Achievements and progress are reported, and the many open questions are discussed, which should provide a sound basis for present and future prospects.

