MAR07-2006-002806

Abstract for an Invited Paper
for the MAR07 Meeting of
the American Physical Society

Failure of heterogeneous materials: Scaling properties of fracture surfaces and implications on models of cracks in disordered media.

DANIEL BONAMY[1], Groupe Fracture DSM/DRECAM/SPCSI CEA Saclay

While there exists a unified theoretical framework - Linear Elastic Fracture Mechanics (LEFM) - to describe the failure of homogeneous materials, understanding and modelling the mechanical properties of heterogeneous media continue to raise significant fundamental challenges. These mechanical properties, observed at the macroscopic scale, result from microscopic processes occurring at the scale of the material. To include these local processes into a statistical description constitutes then a crucial step toward the setup of predictive macroscopic models. Crack surface roughness is a consequence of these local processes. Consequently, many fractography experiments have focussed on their analysis. In this context, it was recently evidenced that, in many materials, fracture surfaces exhibit anisotropic scaling properties reminiscent to interface growth problems, fully characterized by two couples of parameters: The roughness exponents and the characteristic length-scales measured along and perpendicular to the direction of crack growth respectively. While the characteristic length-scales do depend on the considered material, the exponents are surprisingly universal: Two *distinct* sets of critical exponents are observed whether the surfaces are examined at scales below or above the size of the damaged zone at the crack front. Models of crack growth in disordered media are discussed at the light of these experimental observations. In particular, one can derive a model from LEFM which describe the development of crack roughness as an "elastic" manifold creeping in a random media. This approach captures quantitatively the experimental observations performed at length-scales above the size of the process zone. In this approach, the onset of crack propagation can be interpreted as a dynamic phase transition while sub-critical crack growth can be assimilated to thermally-assisted depinning.

[1]with Laurent PONSON, Elisabeth BOUCHAUD, Harold AURADOU, Jean-Pierre HULIN