Service de Physique de l'Etat Condensé (SPEC)
Département de Recherche sur l'Etat Condensé, les Atomes et les Molécules
Direction des Sciences de la Matière
Commissariat à l'Energie Atomique

Séminaire du SPEC

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Bt. 774 - Salle Claude ITZYKSON
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Slow crack growth : Influence of material properties

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In elastic material : We present experiments on the slow growth of a single crack in a fax paper sheet submitted to a constant force F. We find that statistically averaged crack growth curves can be described by only two parameters : the mean rupture time and a characteristic growth length. We propose a model based on a thermally activated rupture process that takes into account the microstructure of cellulose fibers. The model is able to reproduce the shape of the growth curve, the dependence of the characteristic length on F as well as the effect of temperature on the rupture time. We find that the length scale at which rupture occurs in this model is consistently close to the diameter of cellulose microfibrils [1]. We also study the non-averaged crack growth curves which present a stepwise growth dynamics. We model the material as a lattice where the crack is pinned by elastic traps and grows due to thermally activated stress fluctuations. In agreement with experimental data we find that the distribution of step sizes follows sub-critical point statistics with a power law (exponent 3=2) and a stress-dependent exponential cut-off diverging at the critical rupture threshold [2].

In viscoelastic material : We study experimentally the slow growth of a single crack in polycarbonate films submitted to constant and uniaxial stress. The specificity of fracture in polycarbonate films is the appearance at the tip of the crack of a macroscopic flameshaped plastic process zone. We observe that crack growth curves obey remarkable scaling properties. Additionally, a unique dependence of the rupture time of the samples with respect to the applied stress as well as the crack and process zone lengths during the crack growth is obtained if one considers the plastic process zone stress to be a Dugdale-Barenblatt out-of-equilibrium stress. A very similar dependence holds for the growth under constant stress, in non-fractured films, of a macroscopic plastic deformation band which is completely identical in nature to the plastic process zones at the cracks'tips. The comparison between the two exponential growth laws suggests that he crack growth in polycarbonate films is very much linked to the dynamics of the elastic-plastic transformation of the material.

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