DISSIPATIVE PROCESSES ACCOMPANYING THE FRACTURE OF GLASS

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It has been shown long ago that although glass is often presented as the archetype of elastic brittle materials, some energy must be dissipated during fracture. The origin and the extent of this dissipation is still a controversial problem.

We present here two series of experiments where glass is broken either quasi-statically or dynamically. In the first case, a subcritical crack is grown in a controlled stable way within a saturated heavy water atmosphere. Neutron reflection experiments aimed at probing the quantity of water stored under the fracture surface after the sample has been broken, show clearly that heavy water actually penetrates into the bulk around the crack tip by ~10nm during the fracture process. Since water molecules hydrolyze the Si-O bonds, their presence reveals the existence of nanocracks which dissipate a significant part of the mechanical energy.

In the dynamic fracture regime, where water does not play any role, damage formation arises at much smaller scales, and dissipative processes within the plastic zone result into its strong heating. We detect photons which are emitted during fracture and show that they are mostly of thermal origin. The estimate of the temperature increase observed within the plastic zone allows for an estimate of the crack velocity, the stress intensity factor and the plastic zone size.