Nano-scale ductility of glass as evidenced by atomic force microscopy experiments

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We have studied the low speed fracturation regime (10^{-3} – 10^{-10} $m.s^{-1}$ and below) for aluminosilicate glasses in a carefully mastered surrounding atmosphere. The chosen mechanical system enabled us to work in pure tensile mode (mode I). By using optical and atomic force (AFM) microscopy techniques we characterised in real-time the fracturation processes.

Our *real-time* experiments clearly reveal -for the first time- that the crack progresses from the nucleation, growth and coalescence of nanometric damage cavities. This phenomenon is similar to the classical "ductile" fracture mode of metallic materials, widely observed at much larger length scales – 50 to 100 µm –. The presence of these cavities is confirmed by a second independent method using the Fracture Surface Topography Analysis (FRASTA) technique [1] well known in metallurgy. The nucleation of cavities which grow under the stress imposed by the presence of the main crack is inherently linked to the amorphous structure, which reveals atomic density fluctuations at the nanometer scale. These "pre-cavities" may behave as stress concentrators, which triggers their growth. Our observations are fully consistent with recent Molecular Dynamics simulations [2].

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