TOWARDS A CRACK PROPAGATION CRITERION AND DYNAMIC INSERTION OF COHESIVE ELEMENTS APPLIED TO THERMAL FATIGUE FAILURE OF COMETS/ASTEROIDS

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Résumé

It has been shown that temperature cycles on airless bodies of our Solar System can cause damaging of surface materials[1]. This damaging process, known as thermal cracking, consists in the initiation and propagation of micro-fractures inside the material due to the mechanical stresses induced by the diurnal/nocturnal temperature cycles. Thermal cracking of surface rocks, in addition to the impact of micrometeorties, can eventually lead to rocks' breakup and produce fresh "regolith". Regolith is the layer of unconsolidated material that covers planetary surfaces[2,3]. Furthermore, it is proposed by several studies that also macroscopic fractures, mass-wasting, and material breakdown on asteroids and cometary nuclei could be explained as a consequence of thermal effects[1,4,5]. For all the reasons above, thermal cracking is now considered a space (and Earth) weathering mechanism. Here, we focus on the fracture propagation mechanisms, which are are still poorly understood in the case of space objects.

Crack propagation through a finite element mesh for arbitrary crack paths is one of the most challenging issues in computational fracture mechanics. Here it is done based on an advanced remeshing technique. The crack direction is computed using the maximal circumferential stress criterion[6] and the maximal strain energy release rate criterion[7], which are implemented using advanced finite element methods. The propagation of the crack is achieved through the combination of an advanced remeshing technique[8] that enables us to remesh over the computed direction, with dynamic insertion of cohesive elements[9] in the remeshed zone and in a mesh-independent way, allowing in addition, fracture energy control. An overview of crack propagation in brittle materials will be presented for a given mixed mode configuration.

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