Three dimensional internal cracks under sliding spherical contact: a numerical analysis

R. Kouitat Njiwa and J. von Stebut

Laboratoire de Science et Genie des Surfaces
Ecole des Mines de Nancy, Parc de Saurupt
54042 Nancy cedex France

We address 3D modelling of crack propagation in contact problems both for static indentation and for sliding with moderate friction. The analysis uses a specifically developped BEM code yielding both the stress intensity factorts (SIFs) and the energy release rate G as a function of the crack propagation front considered as well as the distance of the flaw from the free surface and the lateral distance from the edge of the Hertzian contact radius.

- In static indentation our numerical results show that for flaw positions sufficiently in-depth as compared to the free surface, crack propagation may well proceed into the bulk.
- In sliding contact with moderate friction we show that flaws very close to the free surface will always give rise to crack propagation towards the free surface. Comparison with experimental data concerning the lateral position of emerging cracks in scratch testing suggests that in the case of the brittle quasicrystals taken as example, the flaws should be very close to the free surface $z_0 / a_H <$ 0.05.
- For sliding contact, the presence of two distinct elementary, pre-existing cracks of the same size gives rise to a reduction in the energy release rate G. For $r_0 / a_H > 1.1$ the crack propagation will then always be towards the free surface.

Experimental validation of these numerical results requires materials with perfectly controlled flaw sizes, flaw densities and flaw positions below the free surface. This is a real challenge to materials scientists as suppliers of such reference specimens.