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Depinning transition in failure of disordered brittle materials[1]

LAURENT PONSON, California Institute of Technology, FEDERAL UNIVERSITY OF RIO DE JANEIRO COLLABORATION — Crack propagation is the fundamental process leading to material failure. However, its dynamics is far from being fully understood. In this work, we investigate both experimentally and theoretically the growth velocity v of a crack propagating in brittle materials in the limit of low velocities compared to the sound speed. The variations of v with respect to the external loading K_I are carefully measured on two kinds of brittle rocks over various orders of magnitude. The crack dynamics is shown to display two regimes, well described by a sub-critical creep law $v \sim e^{-\frac{c}{(K_I-K_0)^\mu}}$ with $\mu \simeq 1$ for $K_I < K_c$, at low velocities, and a critical behavior where $v \sim (K_I - K_c)^\theta$ with $\theta \simeq 0.8$ when $K_I > K_c$. We show that these variations, as well as the value of the exponents μ and θ, can be explained extending the theoretical framework of Linear Elastic Fracture Mechanics to inhomogeneous media. In particular, these two regimes are shown to be reminiscent of the dynamical critical transition underlying the failure of disordered brittle materials.

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