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Critical failure can be tuned by material rheology: A model and a case study.

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The total energy of acoustic emission (AE) events in externally stressed materials diverges when approaching macroscopic failure. Avalanche models explain this accelerated seismic release (ASR) as the approach to a critical point that coincides with ultimate failure. However, not all empirical mechanical processes are critical at failure. As a case study, we show how the soft uniaxial compression of nanoporous materials exhibits ASR but, instead of a singular critical point, the distribution of AE energies is stationary and variations in the activity rate are sufficient to explain the presence of multiple periods of ASR leading to distinct brittle failure events. We propose that critical failure is suppressed in the AE statistics by mechanisms of 'transient hardening'. The same mechanisms can explain the reported temporal correlations between AE events. We compare the experimental results with a solvable mean field model of rheological fracture. This model exemplifies how criticality and temporal correlations are tuned by rheology, effectively acting as a mechanism of transient hardening. The statistical properties depend only on the distance to a critical point, which is universal for any parametrization of the transient hardening in a whole category of fracture models.

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