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Rayleigh-Taylor instability (RTI) for a yield-stress fluid ILHAM MAIMOUNI, Paris-Est University (Navier Laboratory) / Schlumberger (SRPC), JULIE GOYON, Paris-Est University (Navier Laboratory), ETIENNE LAC, NICOLAS FLAMANT, THIBAULT PRINGUEY, Schlumberger (SRPC), PHILIPPE COUSSOT, Paris-Est University (Navier Laboratory) — RTI is of great interest in several domains such as oil industry, geology and high-energy density physics. We experimentally study this instability for a yield-stress fluid, i.e. a fluid that is solid under a certain critical yield stress, and liquid above. For that, we superimpose, at rest, two rheologically - controlled immiscible fluids of different densities, a yield stress fluid under a heavier Newtonian one, and we observe the interface. For a given density difference, the instability occurs below a critical yield stress in the form of fingers of one fluid abruptly spreading through the other one. Above this critical yield stress, the interface remains undeformed. This set of data provides an empirical criterion for the instability. We find that this criterion is neither predicted by simple elastic material theory, nor by the assumption of yielding phenomena at sufficient initial perturbation amplitude. Instead, RTI occurs for a sufficiently larger density difference to yield stress ratio and the finger wavelength is independent of the sample size. Finally we show that the instability characteristics can be explained by the ability of a local perturbation beyond a critical size to penetrate the material.

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