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Transient Networks and Dense Colloidal Suspensions: From Viscous Flow to Elastic Instabilities[1]

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In order to analyze the mechanical response of viscoelastic materials in highly non-linear regimes, we have designed a new kind of Hele-Shaw cell where both viscous liquids and soft elastic solids can be tested at a controlled loading rate. We first consider model Maxwell liquids – characterized by a single relaxation time – with the project of benchmarking the response of complex, glassy systems. We use several solutions of microemulsions connected by telechelic polymers. We show that these materials undergo instability in a broad range of loading rates. At low rates, this instability is shown to be of the viscous Saffman-Taylor type. At high rates, we observe a purely elastic bulk instability discovered recently in the context of soft elastomers. A microfluidic version of our cell makes it possible to study the response of colloidal suspensions. We use more or less concentrated PNIPA aqueous solutions for which temperature controls the volume fraction. Observations are interpreted in the light of our understanding of their viscoelastic properties.

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