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Dynamical and structural transitions in periodically-driven emulsions: Reversibility loss and random hyper-unifom organization JOOST H. WEIJS, Ecole Normale Supérieure de Lyon, France, RAPHAËL JEANNERET, Warwick University, United Kingdom, RÉMI DREYFUS, Centre National de la Recherche Scientifique, DENIS BARTOLO, Ecole Normale Supérieure de Lyon, France — We present experiments and numerical simulations of a microfluidic echo process, in which a large number of droplets interact in a periodically driven viscous fluid [Jeanneret & Bartolo, Nature Comm. **5**, 3474 (2013)]. Upon increasing the driving amplitude we demonstrate the collective reversibility loss of the droplet dynamics. In addition we show that this genuine dynamical phase transition is associated with a structural one: at the onset of irreversibility the droplet ensemble self-organises into a random hyperuniform state. Numerical simulations evidence that the purely reversible hydrodynamic interactions together with hard-core repulsion account for most of our experimental findings. Hyperuniformity is relevant for the production of large-band-gap materials, but are difficult to construct both numerically and experimentally. The hydrodynamic echo-process may provide a robust, fast, and simple way to produce hyper uniform structures over a wide range of packing fractions.

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