Glassy flows in microchannels with structured rough surface

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Rheological behavior of soft glassy materials (SGM) - such as concentrated emulsions, foams, or granular media - strongly depends of the volume fraction of the dispersed phase. At low volume fraction these systems usually can be considered as Newtonian liquids, while above a critical packing fraction they becomes jammed and the flow occurs via a sequence of reversible elastic deformation and irreversible plastic rearrangements associated with microscopic yield stress. The yielding behavior makes such systems as interesting for applications as challenging from the fundamental point of view of out-of-equilibrium statistical mechanics [1]. It has been shown that both confined geometry and rough surface affect the dynamics of rearrangements leading to strong deviation from the bulk rheology. One challenging question therefore concerns the formation of spatially non-homogeneous features, where the global rheology is not able to properly capture the complex space-time behavior of the system [2,3].

Here we study the flow of concentrated oil-in-water emulsion above the jamming point in confined microfluidic channels with structured rough surface. We investigate the fluidity and the activation of plastic events in the terms of the kinetic elasto-plastic (KEP) model [4] close to the boundaries as a function of the structured geometrical roughness. The experimental results are complemented with numerical simulations allowing to study the fluidity field and the rate of plastic events, thus allowing us to establish a link between the mesoscopic plastic dynamics of the jammed material and the macroscopic flow behavior.

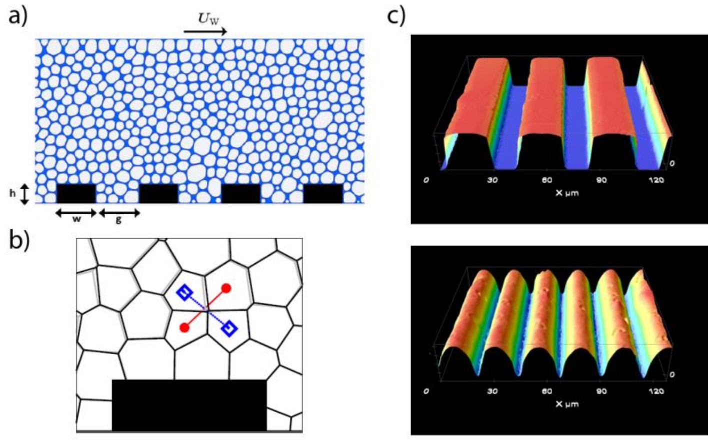

Fig 1. *a) Snapshot from lattice Boltzmann simulations in confined microchannels with structured roughness on the bottom wall. Roughness parameters w, h and g refer to the inter-post width, height and distance respectively. b) Sketch of a T1 plastic event. c) Profilometer image of the wall roughness of different structures.*

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