Colloidal monolayers under steady and oscillatory shear at the liquid-liquid interface

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The macroscopic response of colloidal systems to shear and deformation is directly coupled to their microscopic structural evolution. Unfortunately, in most cases the use of macroscopic rheometers does not allow *in-situ* access to the system's microstructure at the single-particle level.
In this work, we investigate the shear response of soft crystals of charged colloids spread at a water/oil interface, where the microstructure is imaged by optical microscopy. Continuous/oscillatory shear flows are applied by rotating/oscillating micro-fabricated magnetic disks located at the fluid-fluid interface [1]. Upon steady rotation, two regimes of motion are reported. At small shear rates, the monolayers flows via discreet hopping of the particles, i.e., the shear induced motion is defect-mediated. At larger applied rates, the flow induces ordering of the colloidal suspension around the disk, in the form of concentric rings. We also characterize the monolayers viscoelastic response to oscillatory shear flows. The mechanical properties of the 2D-colloidal crystal strongly depend on the amplitude and frequency of the applied perturbation: large amplitudes and small frequencies lead to irreversible plastic rearrangements that alter the monolayer crystalline microstructure.
Furthermore, we study how the presence of a second population of smaller particles affects the mechanical response of the monolayers. Here, the system show glassy properties and the two particle species yield sequentially [2].

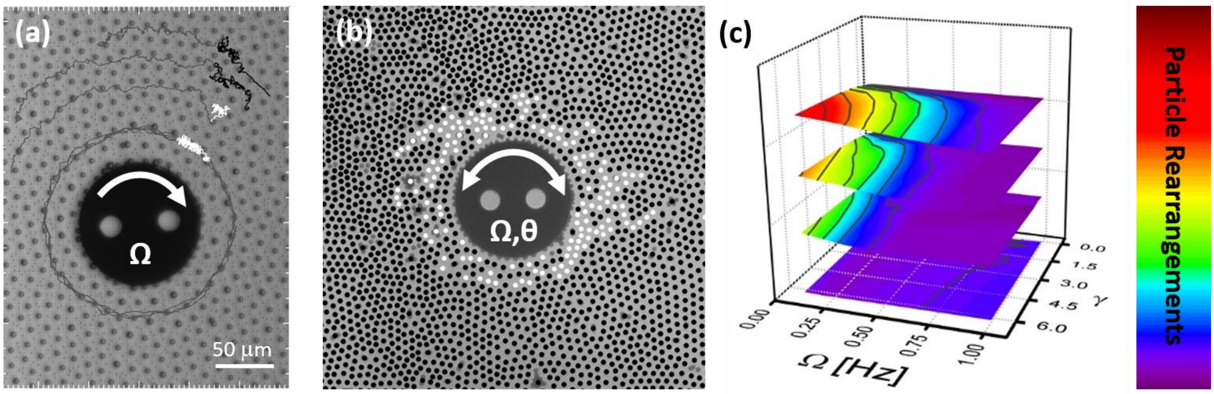

Figure 1 a) Examples of trajectories in the lab (dark grey lines) and in the co-moving reference frame of the flow (black and white) for a monolayer sheared at Ω = 0.3 Hz (steady shear). The white trajectories correspond to Flowing particles, whereas the black trajectories reveal a defect-mediated motion (Hopping particles). **b**) Particle rearrangements under oscillatory shear. The white dots highlight the particles that have moved more than one lattice constant after one oscillation of the disk (frequency Ω = 0.3 Hz, amplitude θ = 20°). **c**) Mechanical response of colloidal monolayers with increasing coverage (from bottom to top), plotted as a function of the local strain γ and the frequency Ω of the applied oscillatory shear flow.

[1] S.Q. Choi, S. Steltenkamp, J.A. Zasadzinski and T.M. Squires, *Nature Comm.*, 2011, **2,** 312.
[2] I. Buttinoni, Z. A. Zell, T. M. Squires and L. Isa, *Soft Matter*, 2015, **11**, 42.