Minicolloque n° MMB16 **X Oral** **□ Poster**

Drying-induced stresses before solidification in charged colloidal dispersions

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We have developed a setup to continuously measure stresses induced by the drying of a complex fluid drop squeezed between two parallel plates [1]. This setup is based on a precision scale working with an electromagnetic force compensation technique that provides accurate measurements of forces, while allowing simultaneously controlled evaporation rates, in situ microscopic observations, and quantitative estimates of normal stresses. We then studied the drying of a charged colloidal dispersion using this device. Stress measurements show the occurrence of large tensile stresses during drying, well-before the solidification evidenced by the invasion of the porous colloidal material by air. Combined measurements of solid deformation and concentration profiles show that these stresses are due to the formation of a soft solid at a low volume fraction, which further undergoes drying-induced shear deformations up to the colloid close-packing, as also supported by large deformation poroelastic modeling. Above all, our results highlight the importance of repulsive colloidal interactions in the build-up of mechanical stresses during drying.

[1] A. Bouchaudy. J.-B. Salmon, Soft Matter 15, 2768 (2019)

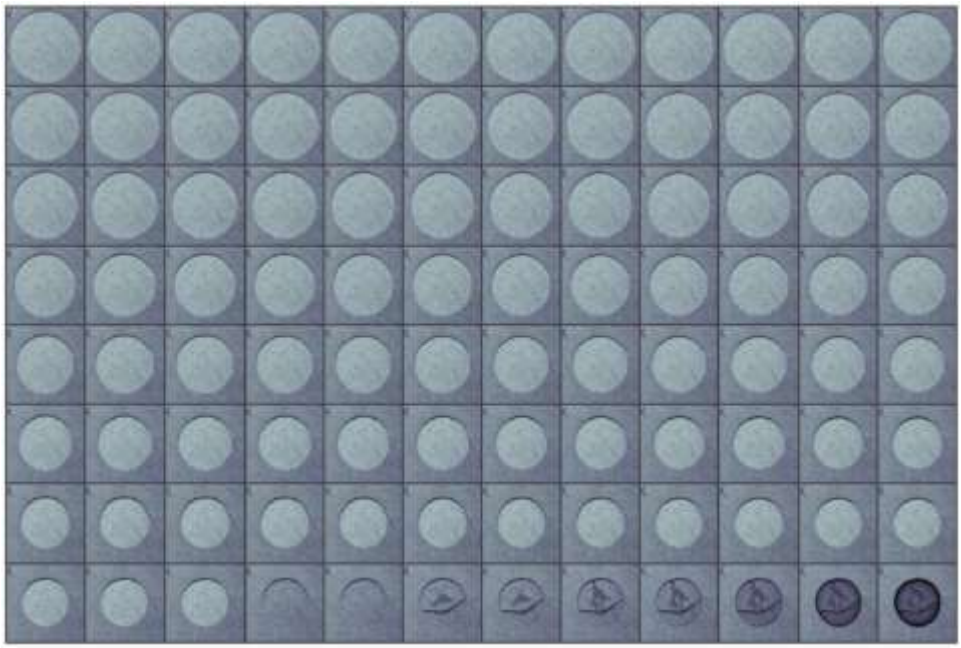

Figure 1 : Time series of snapshots showing the drying of a confined drop of a charged colloidal dispersion until its complete solidification. The initial diameter of the drop is 3 mm.