Drying of colloidal suspensions of hard spherical particles on soft swollen hydrogels

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Evaporation of sessile droplets on various surfaces has been the topic of several publications over the past years. Many of the studies focus on the coffee-ring effect - the formation of a circular, densely packed deposition of particles during the drying process of colloidal suspensions - as well as ways to suppress it.

The presented work examines the drying behaviour of sessile drops containing dye-labelled silica particles on swollen poly(N-isopropylacrylamide) hydrogel discs. To investigate the changing distribution of particles within the droplet during the drying process, brightfield and confocal microscopy methods were utilized.

The investigation showed, that the drying process of a sessile droplet on a swollen hydrogel is significantly slower compared to regular hard surfaces, resulting in the lack of pronounced evaporation-driven particle flows. As a result, the particles aggregate at the air-water and liquid-gel interfaces as shown in Fig. 1 (a). For sufficiently low concentrations this leads to a low amount of free particles within the droplet that could be driven towards the edge by more pronounced flows as the drop dries out. Consequently, there is no distinct coffee-ring formation (see Fig. 1 (b)). For high concentrations of particles, it was observed that the excess particles still, albeit slowly, express the typical movement towards the droplet edge and form a coffee-ring.

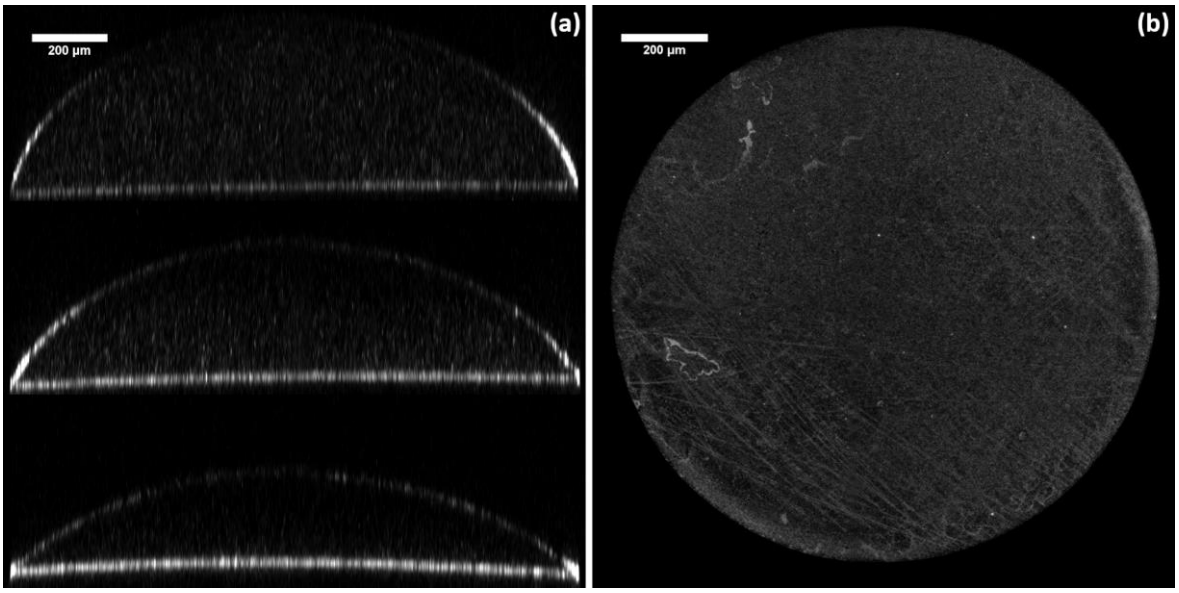

Figure 1. (a) Cross-sections, reconstructed from confocal microscopy images, through the centre of a drying droplet after 8, 23 and 38 minutes, displaying the aggregation of particles over time at the interfaces. (b) Image of the surface of a hydrogel after complete drying of the droplet shown in (a).

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