Droplets covered by particles: Physics and applications

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Abstract: Clay and colloidal particles of nano- and micrometer size adsorb strongly at liquid interfaces where they display a wide range of studies and applications [1],[2], for instance to stabilize emulsions, in material development and to encapsulate, store and release a range of materials such as medicine, cells, food or oil. Structuring of particles on droplets is a particularly hot topic these days with increasing interest and efforts devoted to the synthesis of functional colloidal capsules. Such capsules, with tailored physical, chemical or morphological characteristics, can be used as building blocks to prepare complex structures with advanced and novel material properties [3]. The talk will demonstrate and explain how weakly conductive (leaky-dielectric) droplets behave when suspended in another weakly conducive fluid and subjected to an external electric field. Especially how electrohydrodynamic and eletrorheological effects in such droplets can be used to structure and dynamically control colloidal particle assemblies at droplet surfaces. This includes electric-field-assisted convective assembly of jammed colloidal “ribbons” (figure 1, left), electrorheological colloidal chains confined to a two-dimensional surface and spinning colloidal domains.

In addition, the talk will demonstrate the size control of “pupil” like openings in colloidal shells (figure 1, middle) [4], present a simple and robust method to assemble colloidal shells of controlled heterogeneity (figure 1, right) [5] and discuss some of the many applications for particle covered droplets.

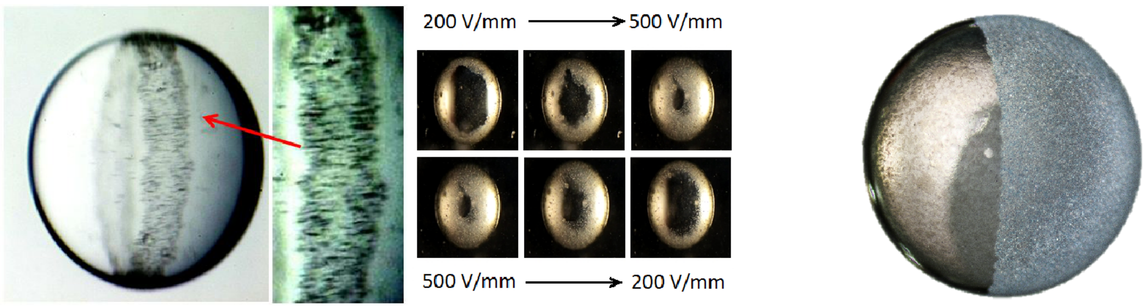

Figure 1: *10 µm sized clay particles forming a ribbon on a silicone oil droplet surface (left). Contraction and expansion of a pupil-like colloidal shell (middle). A Janus colloidal capsule consisting of 500 and 1000 nm sized glass and plastic particles (right). Figures from [4] and [5].*

References:

[1] B. P. Binks, Curr. Opin. Colloid In. **7**, 21 (2002).

[2] C. Zeng, H. Bissig, and A. D. Dinsmore, Solid State Commun. **139**, 547 (2006).

[3] B Bollhorst, T., K. Rezwan, and M. Maas, Chemical Society Reviews, **46**, 2091 (2017).

[4] P. Dommersnes, Z. Rozynek, A. Mikkelsen, R. Castberg, K. Kjerstad, K. Hersvik, and J. O. Fossum, Nat. Commun. **4**, 2066 (2013).

[5] Z. Rozynek, A. Mikkelsen, P. Dommersnes, and J. O. Fossum, Nat.Commun. **5**, 3945 (2014).