

CAN WE MAKE MONEY WITH THE RE-ENTRY PHENOMENON IN COLLOIDAL DISPERSIONS?

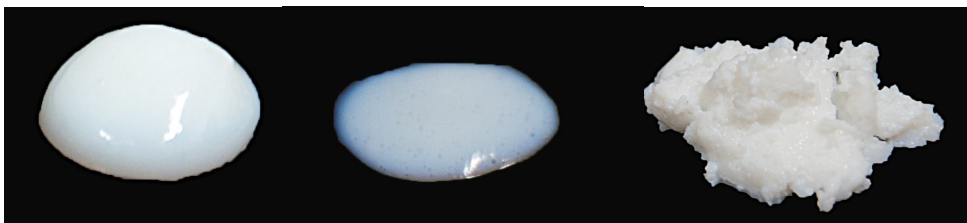
N. Willenbacher¹, J.S. Vesaratchanon¹, O. Thorwarth², E. Bartsch²

1 - Karlsruhe Institute of Technology, Institute of Mechanical Process Engineering and Mechanics, Karlsruhe, Germany

2 - University of Freiburg, Institute of Physical Chemistry, Freiburg, Germany

norbert.willenbacher@kit.edu

Highly concentrated colloidal dispersions exhibit crystalline or glassy structures resulting in a high dispersion viscosity which thereby limits their technical handling and application. Mode coupling theory has predicted that it is possible to fluidize highly concentrated dispersions by introducing a weak attractive interaction while stronger attraction again leads to a non-ergodic gel-like state. This so-called re-entry phenomenon opens up a new route to manufacture highly concentrated, freely flowing dispersions. We have performed steady as well as oscillatory shear experiments on two model dispersions: polystyrene microgel particles suspended in an isorefractive organic solvent and polystyrene-butylacrylate particles with short range repulsive interactions dispersed in water. The former system is transparent enough to allow for dynamic light scattering experiments to study particle dynamics, the latter is close to technical polymer latex systems. Fluidization was achieved by introducing weak depletion attraction among particles via addition of non-adsorbing polymers to the continuous phase, i.e. polystyrene in the case of the microgel suspension and polyethylene oxide (PEO) in the case of the aqueous dispersion. It was found that fluid states exist up to volume fraction, $\phi \approx 0.69$ for the microgel and up to $\phi \approx 0.64$ for the aqueous system. The low shear viscosity goes through a deep minimum as the polymer concentration varied. In the case of the aqueous dispersion, fluidization was observed for a broad range of polymer molecular weights, M_w and the respective viscosity minimum did not vary systematically with M_w variation. The fluidized dispersion can easily spread out on a flat surface whereas glassy dispersion remains its shape due to high viscosity. Further addition of PEO leads to strong attraction at which the fluidization is reversed. (See figure). The viscosity vs. shear rate curve for our fluidized aqueous dispersion is fairly close to that for the commercially available polymer dispersion utilizing broad multimodal size distribution (Acronal V215, BASF SE). This demonstrates a competitive strategy in manufacturing freely flowing but highly concentrated dispersions. Moreover, synergistic effects may allow for a further viscosity reduction if weak attractive interactions are induced in dispersions with broad particle size distribution.



Texture of aqueous dispersion without PEO (left) and with added PEO ($M_w = 4000$ g/mol), polymer concentration $c_p = 5$ g/l (middle) and $c_p = 10$ g/l (right) at $\phi = 0.64$.