Small Scale Transport Group

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We are looking for graduate students and post doctorate fellows who are interested in theoretical or experimental work in the fields of colloid physics and microfluidics. Candidates of engineering, chemistry, or physics background are welcomed to apply.

About us

In our group we use both theory and experiment to study the dynamics of colloidal systems, liquid films, and coating systems. Specifically, the study concentrates on the deposition of colloidal particles for improving fabrication procedures for microelectronic devices, water recovery in the oil industry, and particles/interface dynamics on microfluidic platforms in the presence and absence of MHz-frequency acoustic waves. Some of our active projects are given below:

Pattern deposition (evaporative self assembly)

The pattern deposition of polymers and nanoparticles from a volatile carrier liquid is employed nowadays for the manufacturing of arrays of electrical circuits; e.g., touch screens, infrared antennas, Faraday cages, etc. We use both theory and experiment to study fundamental aspects of pattern deposition. In particular, we concentrate on contributions of colloidal forces (van der Waals forces, electrical double layer forces, molecular steric forces, etc.) between nano-particles and between the particles and the solid substrate to the morphology of the deposit.

Stability of colloidal suspensions and emulsions

The stability of suspensions and emulsions determine the shelf life of products that are made of complex fluids, such as milk, paint, shampoo, etc. and the quality of coating and many device fabrication processes. Moreover, the stability of suspensions and emulsions determine the efficiency of separation processes in the mining, petroleum, and chemical industries.

We study the recovery of water that was used in the petroleum industry for the extraction of oil from wells in the ground. The used water product is contaminated by bitumen particles and hydrocarbons in the form of solute molecules and suspended drops. An efficient separation of contaminates from the water phase is conducted by the destabilization of the contaminant particles and drops. The destabilized contaminants undergo particle coagulation and drop coalescence, which allow for the extraction of the water phase.

We investigate the destabilization of the contaminant phases by altering the colloidal forces between the particles and the drops while accounting for hydrodynamic contributions. Theoretical analysis is combined with different model experimental systems for the identification and verification of the mechanisms taking place during the dynamic collision of particles and drops in water and the consequent coagulation and coalescence processes.

Acoustic flow in thin liquid films and acoustowetting

The flow of fluid, which is excited by acoustic waves, is known as acoustic streaming. KHz to MHz acoustic excitations (in particular surface acoustic waves – SAWs – and Flexural waves) are employed nowadays in order to actuate and manipulate liquids and particles on microfluidic lab-on-a-chip platforms, enhance mass and heat transport in fluids, repel water off solid surfaces, etc. We explore the mechanisms that give rise to the greater efficiency of the process of electro–polishing under the influence of KHz–MHz flexural acoustic waves. In addition, we explore coating (acoustowetting) of solid substrates under the influence of MHz surface acoustic waves.