Mimicing micro-fluidic Pumping Scenarios between Drops and Bubbles using Atomic Force Microscopy

R.R. Dagastine, R.F. Tabor, C. Wu, F. Grieser, D.Y.C. Chan (University of Melbourne)

Understanding the mechanics and outcome of droplet and bubble collisions is central to a range of processes from emulsion stability to mineral flotation. The atomic force microscope has been shown to be sensitive and accurate in measuring the forces during such interactions; in combination with a suitable model framework, a powerful tool is obtained for understanding surface forces and droplet stability in dynamic systems. Here we demonstrate for the first time that this process is not limited to linear motion, and that accelerating, decelerating and cyclical droplet velocities can be used to explore the collisions between droplets and bubbles in ways that much more closely mimic real systems. This talk will focus on what we can learn from the direct force measurement of sequential collisions of pairs of micro-drops or micro-bubbles in order to mimic pumping conditions in micro-fluidic devices(1), see Fig. 1. A number of diverse velocity drive profiles were used to drive to drops together with repeated collisions including waveforms for sinusoidal, peristaltic and diaphragm pumping using AFM. In most cases, it was shown that when equilibrium interactions of the drops were in a meta-stable state, small perturbations in pumping conditions could cause drop coalescence. This was further probed through using simple constant velocity approach and retract cycles where the approach and retract velocities were varied independently. Agreement between quantitative modeling of these collisions and the experimental measurements allows for visualization of the thin film and pressure profiles during these processes. Further, it is shown how this model can be used as a predictive tool to determine whether a given droplet collision will be stable or coalescent

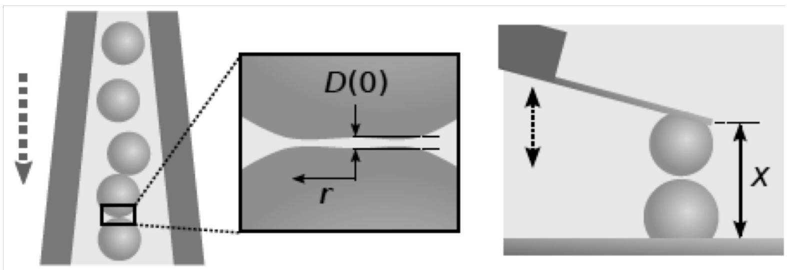

Fig. 1 Droplets in a micro-fluidic channel where the geometry causes their average separation to decrease. The zoomed region shows the film formed between two droplets at close approach. The central film thickness, *D(0)* and radial coordinate *r* are labeled. The AFM setup used, with a drop captured on the cantilever and one immobilised on a solid surface. The control parameter in AFM measurements is ΔX, the change in separation, *X*, between the end of the cantilever and the substrate.

1. Tabor, Wu, Grieser, Chan, Dagastine, *Soft Matter*, 2013, 9, 2426-2433.