3D PARTICLE TRACKING IN SESSIL EVAPORATING WATER DROPLETS

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Our study comprises the experimental and numerical analysis of the 3D motion of particles in suspension inside evaporating sessile drops of water. The main objective is to track individual particles (1micron polystyrene spheres) throughout the evaporation process to correlate the initial position of suspended particles and their final positions on the sediment. As it has been documented before [1], the process has two characteristic times; the slow, initial part and the fast final part when the drop is a liquid film that rips off the contact line. The experimental observations are made with an inverted microscope equipped with two cameras with different image acquisition rates to capture the events with the two time scales, and an oscillating objective for z multiplane acquisition (see [2]). Microscope images at fixed heights provide information of the particles at a horizontal plane and known time. Tailoring positions of individual particles, the track can be integrated (modified version of Trackmate, ImageJ software [3]). Figure 1 shows the plan view of the particle tracks of 700 particles for initial and final evaporation parts, which lasted 3 and 1.5 min respectively. Traces are rainbow color coded with respect to their average height (red for higher and blue for lower average z positions).

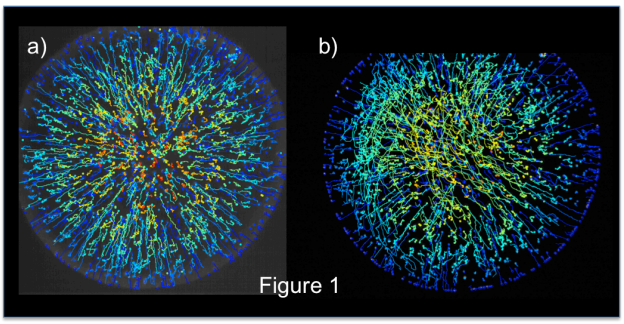

Figure 1

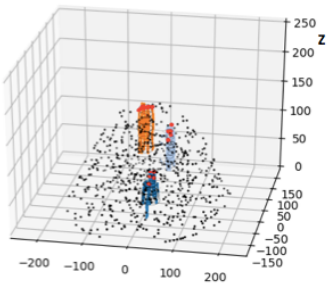

Figure 2

Clearly, the dynamics of the two stages is different with the first being dominated by radial motion and the second by the drag generated by the retreating liquid line after the film pulls away from the contact line. The red traces on the center of Figure 1a) indicate that the particle displacements at the top of the drop are vertical as they are pictured head-on. This is confirmed in Figure 2 where the 3D position of the tracks is displayed. Black dots indicate initial position of particles and color lines are individual tracks during the overall first part evaporation process. Traces that start on the free surface near the top of the drop are nearly vertical (orange lines) while those starting inside the drop have a large radial component. The circles contain the tracers at different horizontal planes and their diameter indicates the spread out of originally neighboring particles. The initial and final diameter of the orange set is approximately the same but the final diameter of the dark blue traces is almost twice as large as the initial one. A numerical simulation of the flow based on the solution of mass and momentum conservation equations with mass loss at the free surface has been performed. The particle tracks are the obtained as streak lines and the agreement is satisfactory.

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