MAR10-2009-001686
Abstract for an Invited Paper
for the MAR10 Meeting of
the American Physical Society

Beetle-inspired Capillarity-based Switchable Adhesion[1]

PAUL STEEN, Cornell University

In a striking display from Nature, the palm beetle defends itself by adhering to the palm leaf with extraordinary strengths. Its survival depends on surface tension through its ability to manipulate an array of 10^5 micron-sized liquid bridges. Inspired by this example, we seek to make a wet reversible super-adhesion device and, more generally, to actively manipulate arrays of coupled droplets/bridges to make useful devices/materials. We first review the chosen activation strategy: electroosmosis (eo) is observed to pump effectively against capillary pressures at small scales. We illustrate using an eo pump to actively toggle between states of the droplet-droplet switch, a two-component bi-stable system. Next, we focus on stability of larger systems in the absence of active elements. Coarsening by capillarity occurs by volume-scavenging amongst many droplets in an array. That is, coupled, communicating droplets naturally reconfigure owing to surface-area minimization. This coarsening behavior evolves to concentrate volume as neighbors scavenge from one other until a single 'winner' emerges. Predicting the identity of the winner and the dynamics of coarsening evolution, which depend on the coupling network size and topology, is the focus. Our solution to this dynamical systems problem will be presented. In closing, there will be a summary of progress toward the super-adhesive device goal.

[1]with MJ Vogel; ack to NSF CBET0653831