Effect of Surface Wettability on Marangoni Flows Generated by Localized Plasmon Resonance

°Gregory A. Pilgrim [1,2], Yudi Tu[1], Toru Utsunomiya[1], Takashi Ichii[1], Hiroyuki Sugimura[1], Kyoko Namura[1], Motofumi Suzuki[1] (1. Kyoto Univ., 2. International Research Fellow of the Japan Society for the Promotion of Science)

E-mail: gpilgrim2670@gmail.com

Here an investigation is conducted into the effects of surface wettabillty on the nature of Marangoni flows at micron scale bubbles [1]. Water vapor bubbles are generated by localied plasmon resonance in irraidated, Au nanoparticle (NP) coated surfaces. Prior to irradiation self assembled monolayers (SAMs) are used to coat NP films, changing their wettability. Film wettability, measured by water contact angle, can be adjusted by vacuum ultraviolet patterning (VUV) and significantly impacts both the shape and size of Marangoni flows over film surfaces.

Gold NP films comprised of isolated NPs roughly 450 Å thick were fabricated by dynamic oblique deposition on glass substrates. Two separate SAMs were then applied in series. The first, derived from hexadecanethiol, assembled on the gold NPs themselves and the second, derived from octadecyltrimethoxysilane, assembled on the glass substrate exposed between NPs. As fabricated both SAMs are akyl terminated and thus hydrophobic. Samples were then subjected to VUV for varying lengths of time. VUV oxidizes akly termination, imparting more hydrophilic character. Water contact angle, shown in Figure 1, can thus be varied controlably. On inducement of Marangoni flow several trends emerge, including in changes in flow shape, visualized in Figure 1 with 75 µm diameter polysytrene beads, as well as flow size and bead accumulation, as shown in Figure 2. Work is presented in the context of designing microfludic devices driven by Marangoni flows.

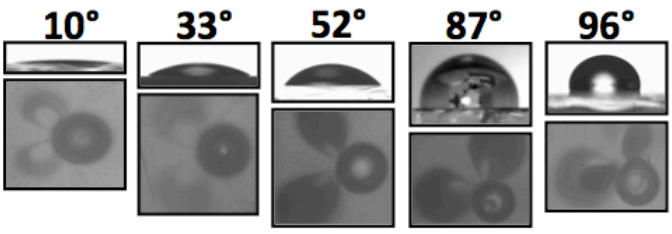

Figure 1: Water contact angles and corresponding Marangoni flow patterns. Bubble diameters are all approximately 50 µm.

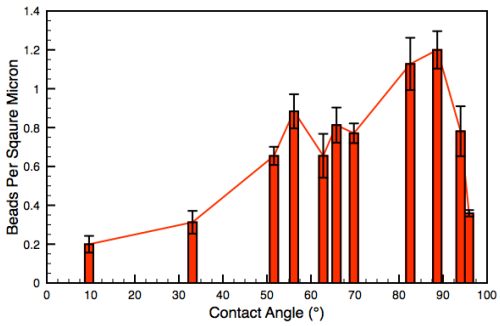

Figure 2: Bead density in Marangoni flow areas on surfaces of differing wettability.

[1] K. Namura et al., Appl. Phys. Lett. 106, 043101 (2015).