1. Introduction

Condensation control on heat exchangers (HXs) can yield tremendous heat transfer enhancements of up to 5-7x. Condensing HXs are used in heating, ventilating and air conditioning systems which account for 17% of total global energy consumption.

Superhydrophobic (SHPB) surfaces can promote dropletwise over filmwise condensation thus increasing liquid mobility, reducing thermal resistance and raising heat transfer rates, offering a plethora of applications from self-cleaning surfaces to enhanced condensation in HXs and anti-icing on aircraft.

Optical lithography (OL) allows precise control over nanoscale structural geometry, is a relatively low cost micro/nanofabrication technique and allows fast fabrication compared with other common micro/nanopatterning methods. Here we present a survey of structures fabricated using OL means and their resultant wetting characteristics along with two novel hierarchical structures, one of which has greater order in its nanoscale features, and utilizes low cost materials such as a 3M Command strip. Inset: image showing pillar height. The lotus leaf exhibits a contact angle of 160° and a 110° contact angle. (B) Wetting state profile of the platinized 2 µm lines achieving a contact angle of 160° and a 110° contact angle. (C) Pillar surface having a 2 µm pitch. The droplet volume used in each test was 3 ± 0.1 µL. B demonstrates droplet elongation parallel to the grating lines. This is due to anisotropic in-plane wetting and was present in all microscale grating samples. This anisotropy was retained for droplet volumes in the range 1-10 µL, confirming good coverage of structure over a relatively large area. In Figs. C, the surface consists of pillars which should set up isotropic in-plane wetting. A small degree of anisotropy was present over the range of pillar samples tested but overall the coverage was considered to be reasonably isotropic over the exposure area and adequate for characterizing the wetting state of the samples.

The microstructure (Fig. 5A) was found to have strong hydrophobicity but had high contact angle hysteresis attributed to the pillars promoting a partial Wenzel state, resulting in droplet pinning. Noting that the droplet volume was modified for the microscale samples with a 7 ± 1 µL drop used for all tests.

Figure 2. 3M command strip. Inset: electron microscopy image of covered individual pillars. Inset: increase magnification showing pillar structure.

Figure 6. (a) SEM image of a micro/nanosurface. Microscale pitch = 1 µm, millisecond = 116 nm. The structure was fabricated using LML, followed by SILMIL. The resultant structure had a relatively small microscale height of around 200-300 nm and a nanoscale height of around 100 nm. The exposure field was relatively large being around 1x1 cm². This is crucial in order to have contact between a relatively small droplet and sample. This method can be scaled up through simple modification of our optical setup.

3. Hierarchical Structures

4. Results and Discussion

Surface Wetting Characterisation

5. Conclusions

Future Direction

- Improve micro/nanoscale hierarchical structures by combining SILMIL with etching to generate larger microscale height
- Move to chirped hierarchical structures having hydrophobic gradient for spontaneous droplet motion
- Develop and investigate three-level hierarchical structure that merge the two structures presented herein
- Combine these low cost optical lithographic techniques with other microfabrication techniques to achieve superhydrophobic wetting.