NANO HIGHLIGHT
Wetting of Surfaces with Nano-Scale Topology

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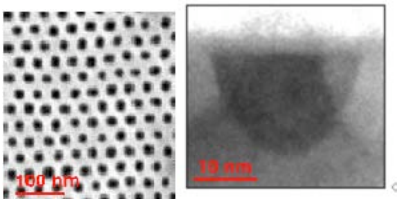

Fig. 1: (Left) SEM top view of the hexagonally packed array of nanocavities. (Right) TEM cross-section of an individual cavity.

Current efforts to develop technologies based on micro- and nano-fluidics promise to provide cost effective methods to deal with basic medical and chemical applications. For example the often discussed 'lab on a chip' should make it possible to carry out scientific experiments and practical diagnostic tests using only small amounts of fluids that would be either costly or dangerous if done with standard amounts.[1] A problem that these developments will eventually encounter is that the properties of liquids that are confined to spaces that are not much larger than the molecular size are often different than those of unconfined liquids. This occurs because of the increased influence of the surface.

We have used synchrotron generated X-rays to study the manner in which liquids condense on nano-scale patterns formed on the surface of silicon by a combination of reactive ion etching and nano-scale patterning with block co-polymers, Fig. 1.[2] Condensation of a liquid, such as methyl-cyclohexane, is controlled by heating the silicon to a temperature DT higher than that of the liquid reservoir. The amount of condensation per unit area σ (i.e. electrons/Å2), as determined from X-ray measurements, is shown by the blue/red curve in Fig. 2. The red line shows the temperature (T) dependence s as the condensing liquid fills the cavities (10K>DT>1K). The blue line indicates the T-dependence for DT<1K after the cavities are filled with liquid. The green line shows the results of the same experiment on a flat Si that has no nano-cavities. The T-dependence of condensation after the cavities have been filled (DT<1K) is identical to that of the flatSi; however, the grow following the initial adsorption is slower. These observations support recent theory.[3]

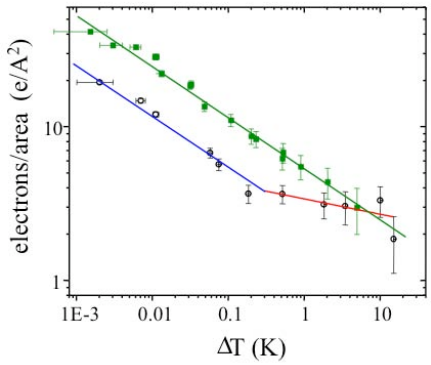

Fig. 2: Temperature dependence of liquid condensation on patterned (blue/red) and flat Si.

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2. T.P. Russell, T. Thurn-Albrecht, M. Tuominen, E. Huang and C.J. Hawker, "Block copolymers as nanoscopic templates", Macromolecular Symposia **159**, 77 (2000).
3. C. Rascon and A.O. Parry, "Surface phase diagrams for wetting on heterogenous substrates", Journal of Chemical Physics **115**, 5258 (2001).