Capillary condensation of water inside atomic-scale capillaries

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Abstract
Capillary condensation of water occurs frequently in our daily life. It has numerous scientific and technological implications in different fields [1]. The Kelvin equation [2] is commonly used to describe capillary condensation, by relating the relative humidity (RH) with the dimension of the capillary/pore under an equilibrium state. Despite based on continuous theory, its validity has been qualitatively proved in an experiment using artificial nanocapillaries enabled by van der Waals (vdW) technology [3]. In this work, we aim to reveal more details of the dynamic capillary filling process based on similar nanocapillaries. To this end, atomic force microscopy (AFM) is used to detect the minute changes in the capillary height profiles as a function of continuously changing RH (**Fig. 1**). We found the layer-by-layer filling of water inside nanocapillaries, which may help us unveiling more interesting properties of 2D confined water.

References

[1] Barsotti et al., Fuel 184 (2016): 344-361.
[2] Thomson, William. Proceedings of the Royal Society of Edinburgh 7 (1872): 63-68.
[3] Yang Qian, et al., Nature 588.7837 (2020): 250-253.

Figures

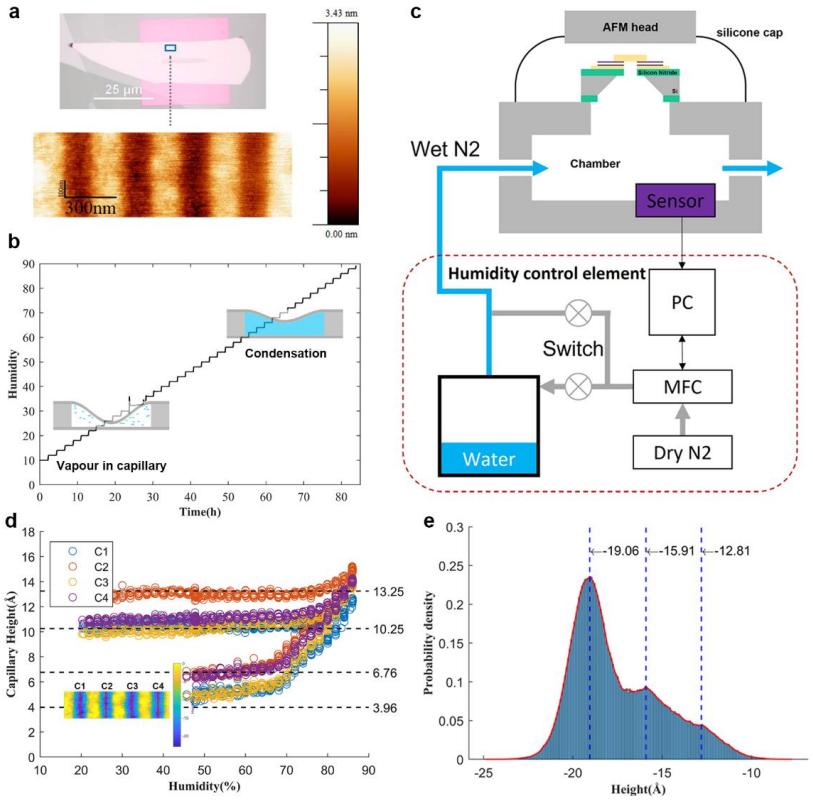

Figure 1. The dynamic filling process of 2D water. a, nanocapillary device and AFM image of test area. **b,** RH versus time curve in a typical experiment. **c,** Schematic of RH control and AFM measurement set-up. **d,** The height of capillaries versus humidity. Inset is the test area and the area (red rectangle) used to calculate the average height. **e,** Height distribution of 'C1' (from **d**) in the whole humidity range.