Electronic Supplementary Material (ESI) for Soft Matter

Modulation of Surface Wettability of Superhydrophobic Substrates Using Si Nanowire Arrays and Capillary-Force-Induced Nanocohesion

Supporting Information

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S1. Au nanoparticle and Si nanowire morphology

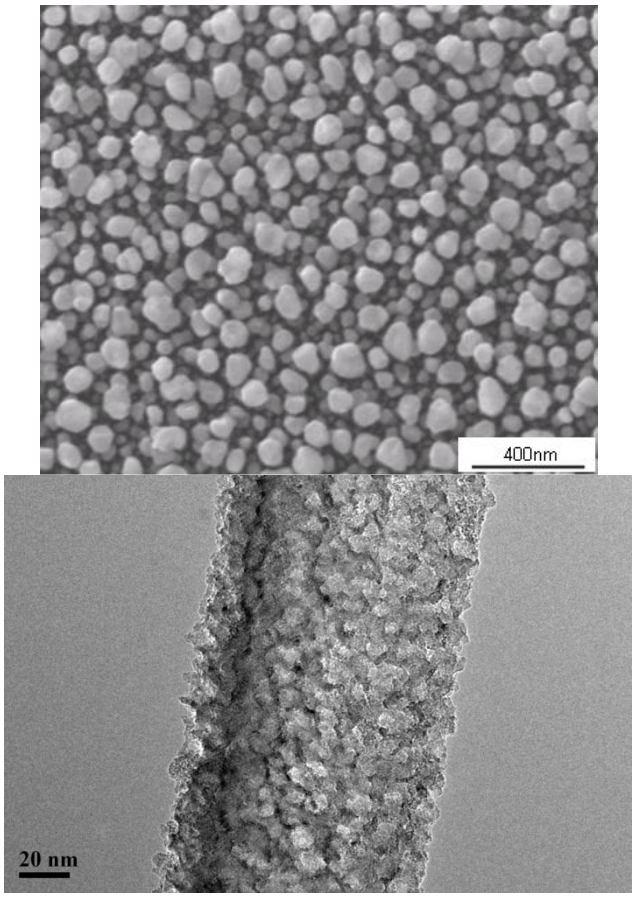

Fig. S1 (a) morphology of Au nanoparticle after GLAD. (b) morphology of mesoporous GLAD-MACE Si nanowire.

S2. Description of procedure for calculating solid fraction *f*

Top-view digital SEM images of the nanowire surface were first converted from the original grayscale into black and white images by applying a suitable threshold using the MATLAB^{TM} image processing toolbox (MathWorks Inc.). The solid fraction f was calculated as the ratio of white pixels (indicating the tips of the nanowires) to the total number of pixels constituting the image.

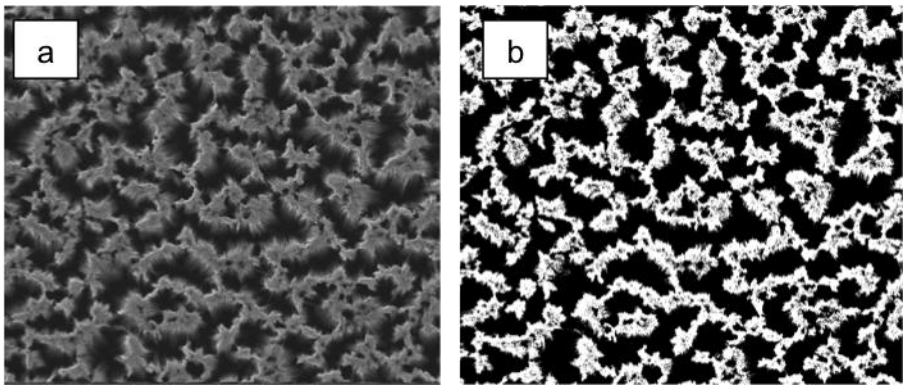

Fig. S2 (a) shows a top-view SEM image of Si nanowire surface, (b) shows a digitized, thresholded black and white image. Solid fraction was calculated as the ratio of white pixels to total number of pixels.

S3. Description of procedure to obtain percolation length

Top-view digital SEM images of the clusters of nanowires were first converted from the original grayscale into black and white images by applying a suitable threshold using the MATLAB^{TM} image processing toolbox (MathWorks Inc.). Next Matlab image processing toolbox was used to determine clusters. For percolation analysis, the probability function, *g(r)*, that a site a distance *r* away belonging to the same cluster is calculated, with *g(r)* taken as an exponential $e^{\frac{-r}{x_i}}$, where x_i is the percolation length.

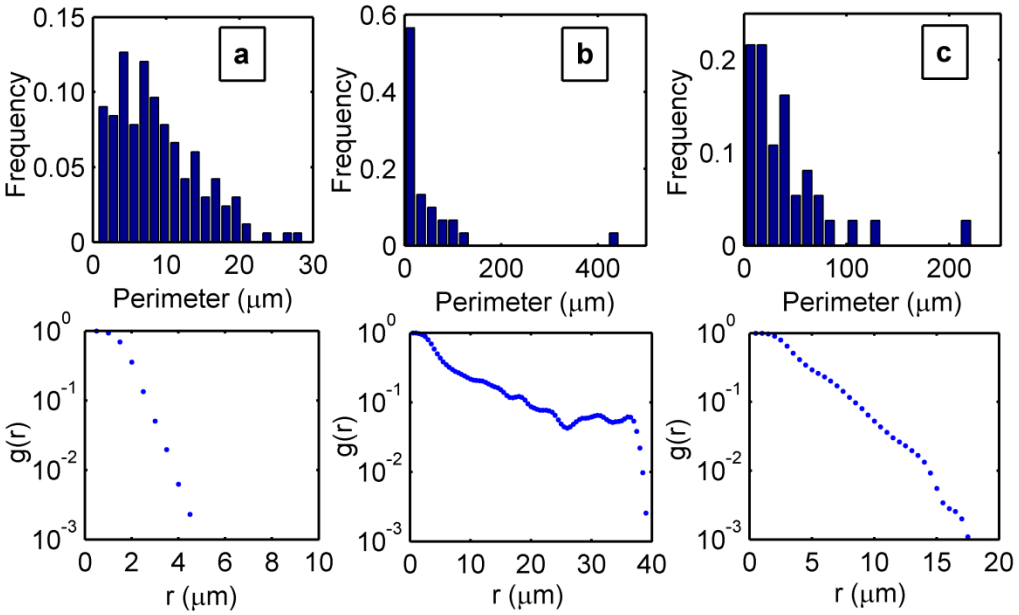

Fig. S3 (Top) Count versus perimeter (percolation length) plots and (bottom) decay in percolation analysis from digitized top-view SEM images of nanowire clusters dried in (a) water, (b) 2-propanol and (c) methanol.

S4. Effect of nanowire stiffness

We synthesized stiffer nanowires by modulating the metal assisted chemical-etching of Si process while keeping the height and the nanowire thickness similar and subjected the samples to the same drying process as mentioned earlier in DI water, 2-propanol and methanol.[1] The same metal assisted chemical-etching recipe was performed. However Au nanoparticles with a smaller size distribution synthesized with a 30 min GLAD duration were used, as explained in our previous work.[1] Figs. S4(a), S4(b) and S4(c) show top-view SEM images of the stiffer nanowires arrays dried in the respective solutions. The average size of nanowire clusters, N, was observed to be smaller in all three cases compared to those in Fig. 1. Due to the stiffer nanowires, E increases, and N, the cluster size, is smaller for all three cases as predicted by equation (1). Note also that the difference in N was observed to be

smaller between Figs. S4(a), S4(b) and S4(c), compared to those of Figs. 1(b), (c) and (d), as a consequence of the fact that for the same applied F_{ST} the stiffer nanowires deflect less and therefore cluster less.

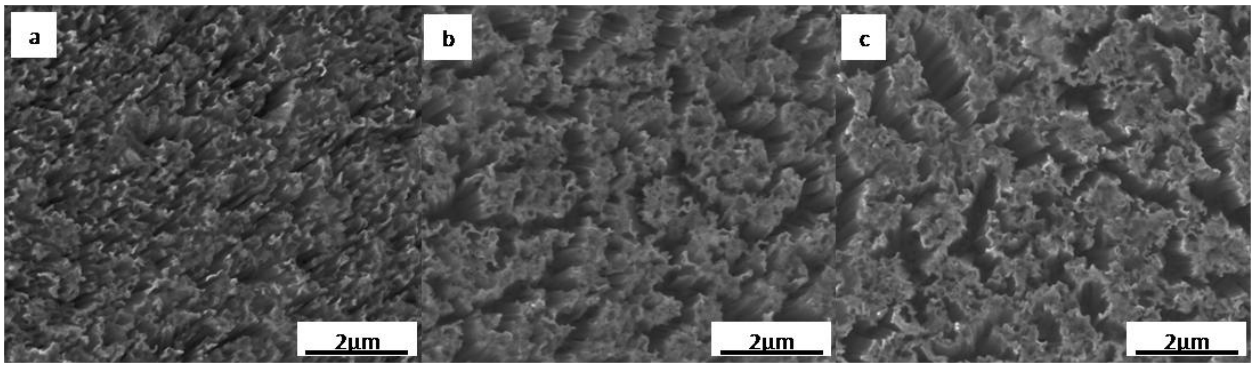

Fig. S4 Drying with stiffer nanowires. SEM images show clustering of nanowires dried in (a) water, (b) 2-propanol and (c) methanol.

S5. Effect of Duration of Chemical Etching

We reduced the duration of the metal-assisted chemical etching of Si process from 20 to 10 min. In doing so, shorter nanowires of ~ 10 μm long were obtained. Figs. S5(a), S5(b) and S5(c) show the corresponding top-view SEM images of the nanowire arrays after undergoing the same drying process in water, 2-propanol and methanol. For the same applied force on the nanowire, the shorter nanowires experience a smaller deflection (based on equation (3)) and hence are only capable of forming smaller sized clusters as predicted by equation (1).

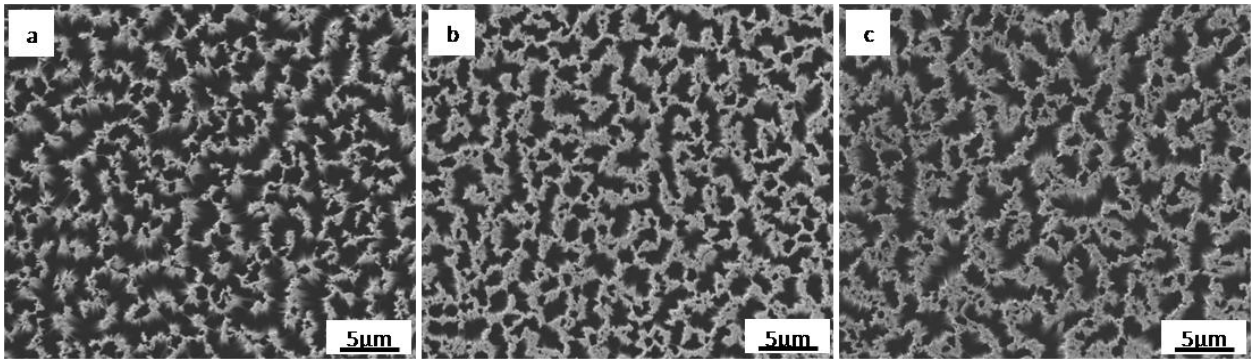

Fig. S5 Drying with shorter nanowires. SEM images show clustering of nanowires dried in (a) water, (b) 2-propanol and (c) methanol.

1 M. K. Dawood, H. Zheng, T. H. Liew, K. C. Leong, Y. L. Foo, R. Rajagopalan, S. A. Khan and W. K. Choi, *Langmuir* 2011, **27**, 4126.