Rational Design of Hyperbranched Nanowire Systems for Tunable Superomniphobic Surfaces Enabled by Atomic Layer Deposition

Ashley R. Bielinski[*⊥], *Mathew Boban*[^⊥], *Yang He*[‡], *Eric Kazyak**, *Duck Hyun Lee*[†], *Chongmin Wang*[°‡], *Anish Tuteja*[^†#$], *Neil P. Dasgupta**

*Department of Mechanical Engineering, [^]Department of Macromolecular Science and Engineering, [†]Department of Materials Science and Engineering, [#]Department of Chemical Engineering, and [$]Biointerfaces Institute, University of Michigan, Ann Arbor, Michigan 48109, USA, [‡]Department of Mechanical Engineering and Materials Science, University of Pittsburgh, Pittsburgh, Pennsylvania, 15261, USA, and °Pacific Northwest National Laboratory, Richland, Washington 99354, USA

Supporting Information

XRD and SEM of Nanosheets:

When an alumina film is used on its own or as an interlayer, the hydrothermal ZnO nanowire growth procedure produces nanosheets instead of nanowires as shown in Figure SI.1b.[1,2] The alumina causes the formation of a Zn:Al layered double hydroxide (LDH) at the interface, which can be identified using x-ray diffraction as shown by the starred peak in Figure SI.1a.[1,3]

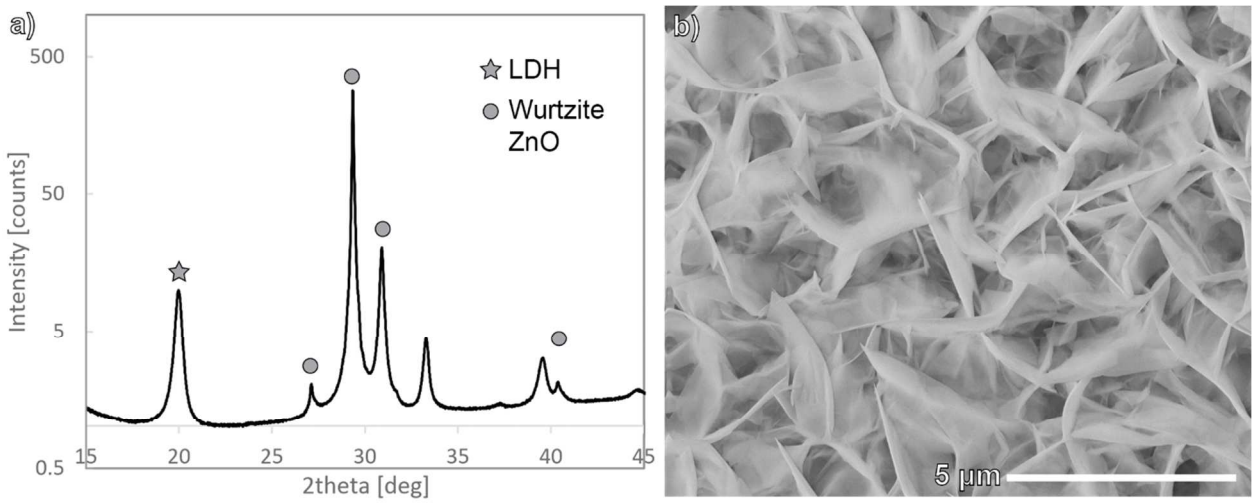

Figure S1: a) symmetric theta/2theta x-ray diffraction pattern showing wurtzite ZnO peaks from the nanosheets and a LDH peak from the substrate. b) SEM image showing the nanosheet morphology.

SI microposts:

Si microposts were used as a high aspect ratio micro-structured substrate. These posts were created using photolithography and Bosch process deep reactive ion etching (DRIE). The Bosch process creates characteristic scalloped side walls shown in Figure SI.2.

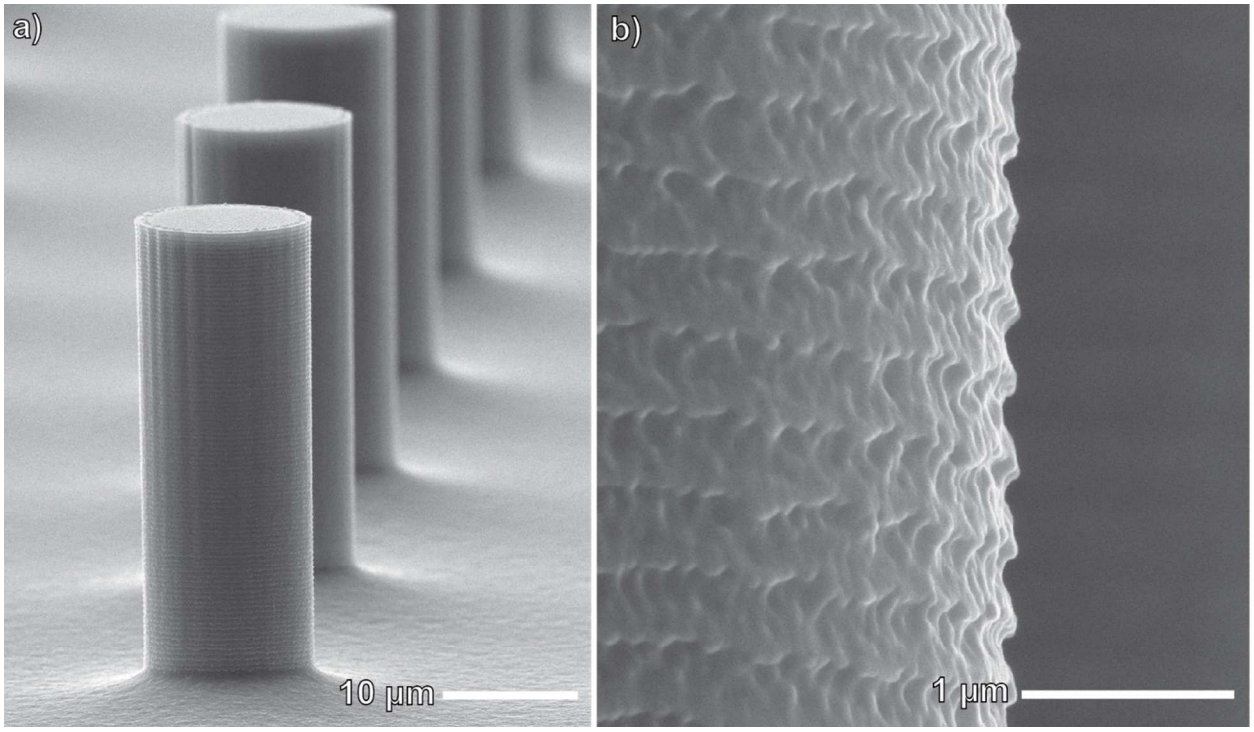

Figure S2: a,b) SEM images showing Si micropost arrays used as substrates. The scalloped side walls from the Bosch process can be clearly seen.

Single level nanowires on Si microposts:

Nanowires of different sizes and densities were grown on Si microposts to create structures with two levels of hierarchy. SEM images showing some of these structures are shown in Figure SI.3.

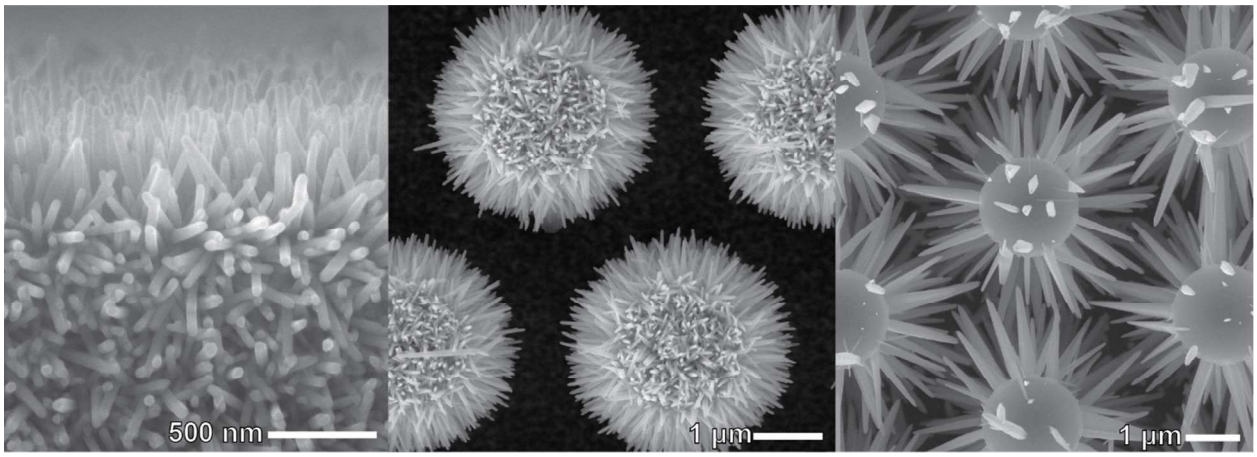

Figure S3: SEM images of Si microposts with ZnO nanowires.

Branched nanowires on diverse substrates:

Most samples were grown on Si wafers, but the ALD seeding is equally applicable to a wide range of substrate materials. Below the branched nanowire growth is demonstrated on polyamide film, glass, and cotton fiber filter paper.

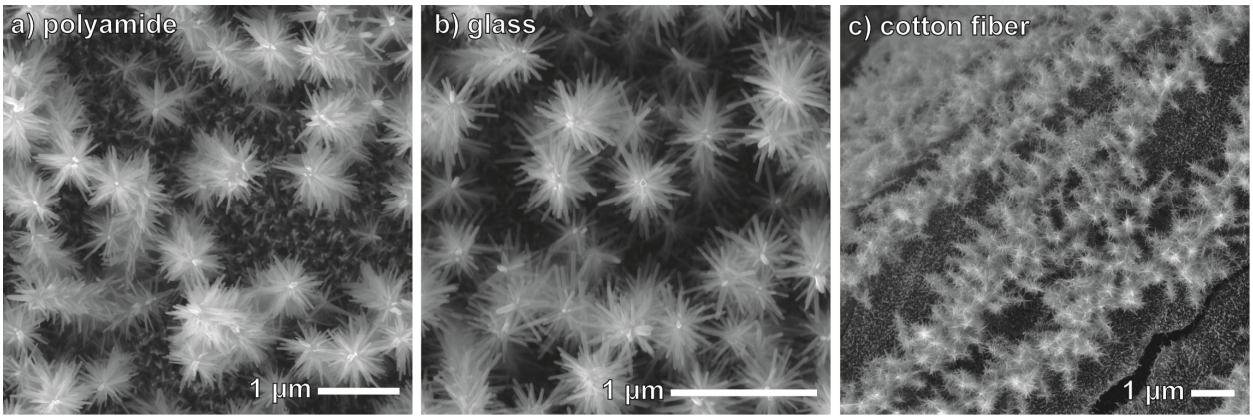

Figure S4: Branched nanowires grown with 5x TiO_2 overlays on a) polyamide film, b) glass slide, and c) cotton fiber filter paper.

REFERENCES

(1) Kim, K.-H.; Kumar, B.; Lee, K. Y.; Park, H.-K.; Lee, J.-H.; Lee, H. H.; Jun, H.; Lee, D.; Kim, S.-W. Piezoelectric Two-Dimensional Nanosheets/Anionic Layer Heterojunction for Efficient Direct Current Power Generation. *Sci. Rep.* **2013**, *3*.

(2) Na, J.-S.; Gong, B.; Scarel, G.; Parsons, G. N. Surface Polarity Shielding and Hierarchical ZnO Nano-Architectures Produced Using Sequential Hydrothermal Crystal Synthesis and Thin Film Atomic Layer Deposition. *ACS Nano* **2009**, *3*, 3191–3199.

(3) Yarger, M. S.; Steinmiller, E. M. P.; Choi, K.-S. Electrochemical Synthesis of Zn−Al Layered Double Hydroxide (LDH) Films. *Inorg. Chem.* **2008**, *47*, 5859–5865.