Electronic Supporting Information (ESI) for "Deposition of high-quality, nanoscale SiO_2 films and 3D structures" by P. Cannon *et al.*

Experimental Details

Microfluidic Device Design

Microfluidic devices were assembled using silicon substrates as the base, alongside polymethlymethacrylate (PMMA) and 86 μm thick pressure sensitive adhesive (PSA) to create the microfluidic channels. PMMA layers were created using an Epilog Zing 16 [Epilog Laser, USA] laser cutter and served to seal the microfluidic channel created by the PSA layer, and to provide the inlets and outlets. The PSA layers were cut using a Graphtec Craft Robo Pro (Graphtec America Inc., USA) knife cutter. First the PSA was bonded to the PMMA top layer using a manual roller, and then the nanostructure coated substrates were bonded to the other side of the PSA layer, ensuring that the nanostructures were facing the PSA and PMMA layers. The schematic diagram can be seen below in figure S.1.

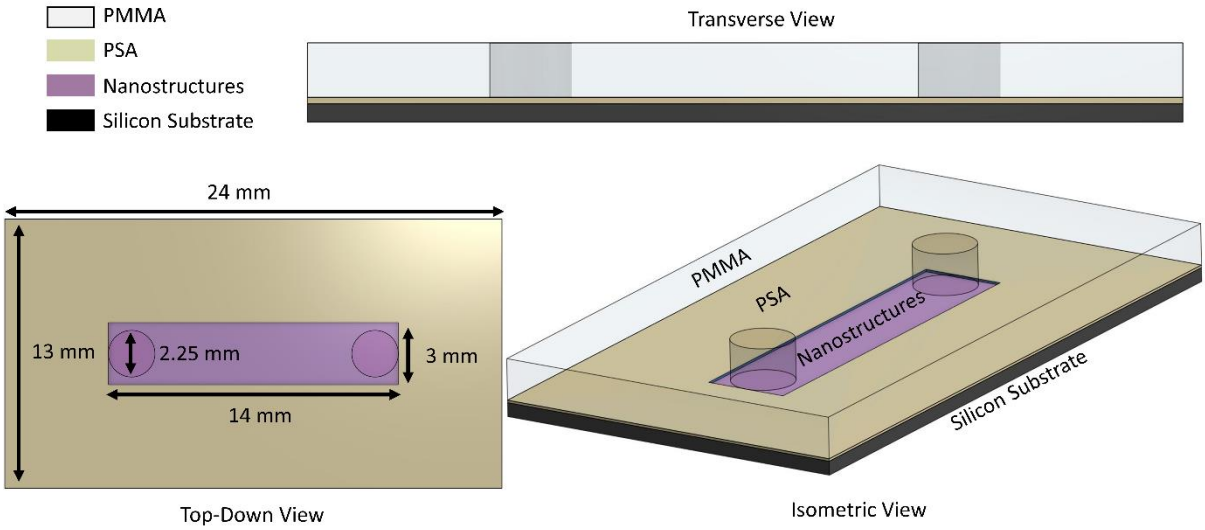

Figure S.1: Schematic diagram of the microfluidic device design utilised for DNA binding studies.

Synthesis of CBD ZnO NR NSL Arrays

An additional ZnO nanorod (NR) morphology was investigated alongside the CTRVPT ZnO NR data presented in the main manuscript (and some additional data is given below for the CTRVPT ZnO NRs).

Ordered arrays of CBD NRs were grown using nanosphere lithography (NSL) to deposit the silica mask through which CBD NRs were grown. The process is described in detail in previous work from our group [1]. After patterning the substrate with the NSL template, the substrate was placed in a beaker under the exact same conditions used to grow the ZnO buffer layer to produce NRs with a height of 300 nm and a diameter of 600 nm.

Results & Discussion

Dendritic 3D SiO_2 Structures

Eight total heating rates were investigated to study the effects of temperature ramp rates of PDMS on deposit morphology. Cross-sectional SEM images of each are shown below in figure S.2.

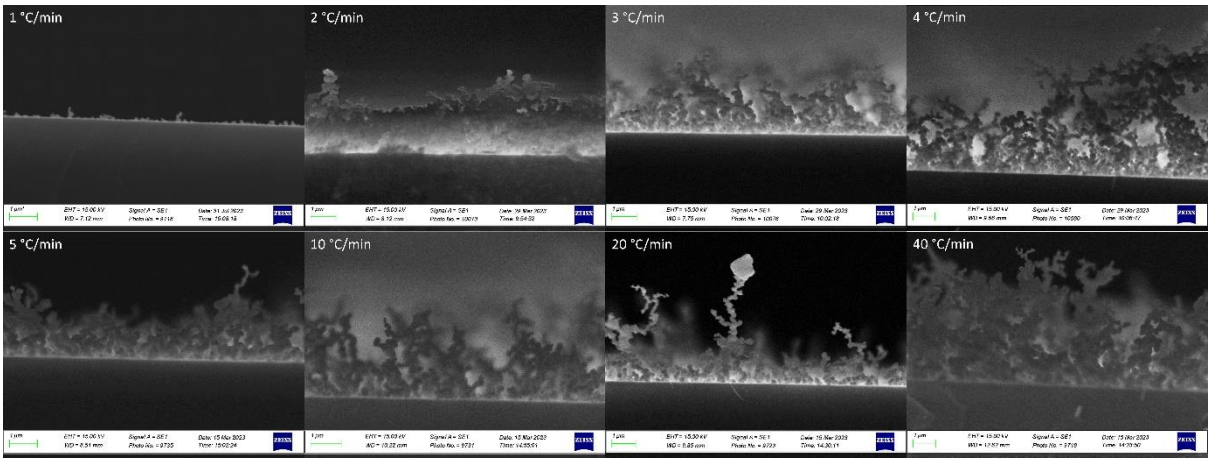

Figure S.2: Cross-section SEM of 3D SiO_2 dendritic structures grown under various heating rates.

CTRVPT ZnO NRs

Alongside using the EDX spectra to measure the SiO_2 shell on ZnO cores, STEM imaging was performed (figure S.3) which agrees with the EDX results. The lower density SiO_2 shell is clearly visible on the denser ZnO core, showing excellent conformality on the ZnO NR faces (and even on slightly rough ZnO faces at the right hand side of the image).

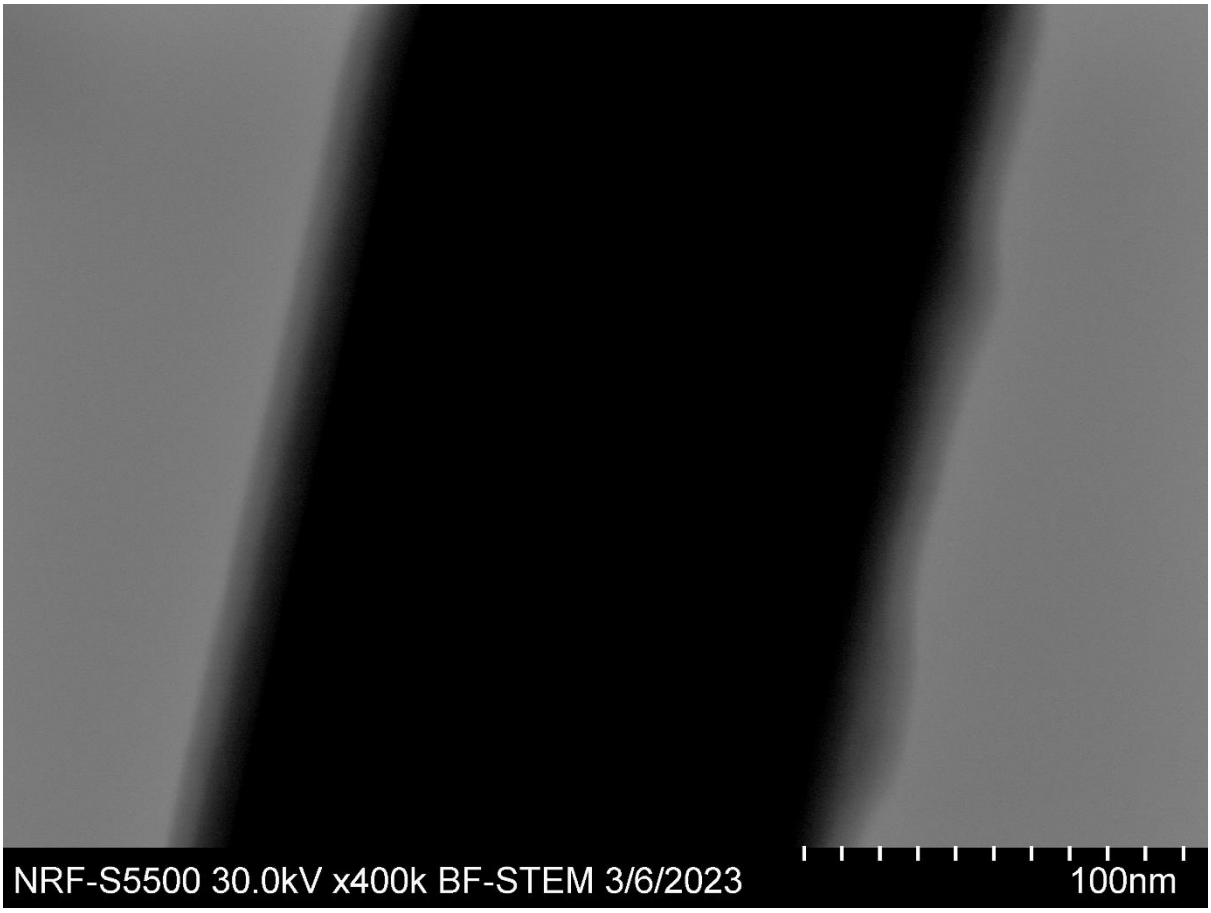

Figure S.3: STEM image of ZnO NR coated in 10.5 nm of SiO_2 using 43.6 mg of PDMS.

Thermionic emission SEM and EDX of CTRVPT ZnO NRs with and without an 11 nm SiO_2 coating was performed to show that no Si signal arises from uncoated ZnO NRs. Cross-sectional SEM images and their corresponding EDX spectra are shown below in figure S.4 (cross-sectional mode was used to avoid interaction with the Si substrate).

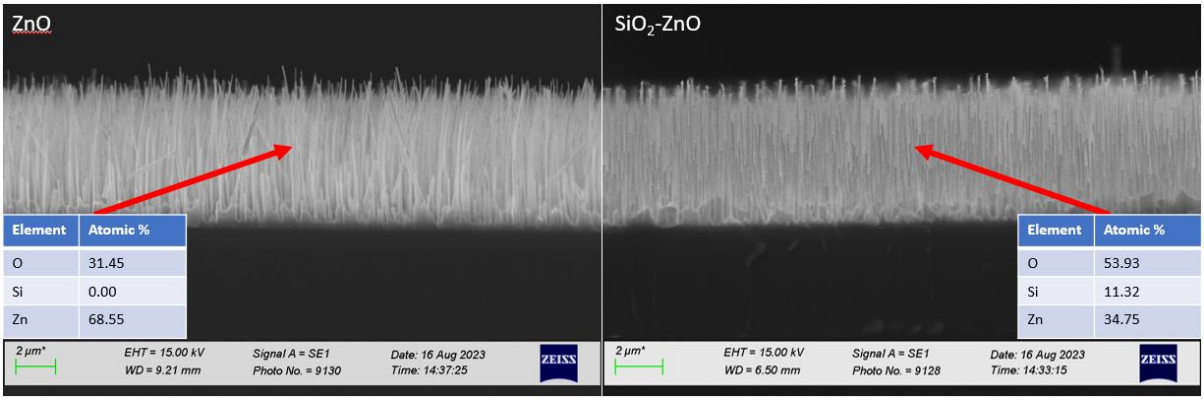

Figure S.4: Cross-sectional SEM and EDX of CTRVPT ZnO NRs before (left) and after (right) 11 nm SiO_2 coating.

XPS data from the same CTRVPT NRs along with data from planar ZnO films and ordered NSL ZnO NR arrays are shown in figure S.5, which again is in agreement with the EDX and STEM results because it shows complete supression of the Zn 2p intensity and complete pinhole free coverage of all three ZnO NR morphologies.

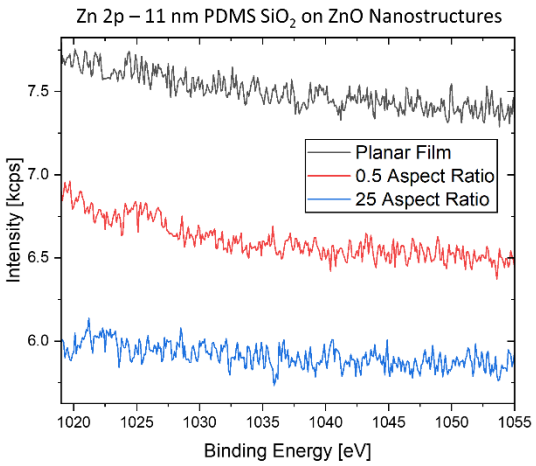

Figure S.5: XPS Spectra of Zn 2p intensity of ZnO nanostructures with various aspect ratios (ARs). 0.5 AR NRs were grown using NSL and CBD shown below in figure S.4, and 25 AR NRs were grown using CTRVPT and are those shown in figure S.2 and S.3.

CBD ZnO NR NSL arrays

In the case of the ZnO NR arrays produced by NSL, two cycles of PDMS SiO_2 deposition was the maximum possible while maintaining the integrity of the ZnO NRs, as they degraded due to thermal cycling with further heat treatments. The XPS analysis was accompanied by SEM measurements and all the results are shown in figure S.6. figure S.6.a-f shows SEM images of the ZnO NRs, both coated and uncoated, at 0 and 60 degree sample tilt angles. The NRs maintain their morphology and structure after SiO_2 coating. Figure S.6.g shows XPS spectra for the Si 2p orbital region, S.6.h shows the O 1s orbital region, and S.6.i shows the Zn 2p region. The presence of a small SiO_2 2p signal (figure S.4.g) in the uncoated NR sample arises from the NSL silica template used to grow the NRs.

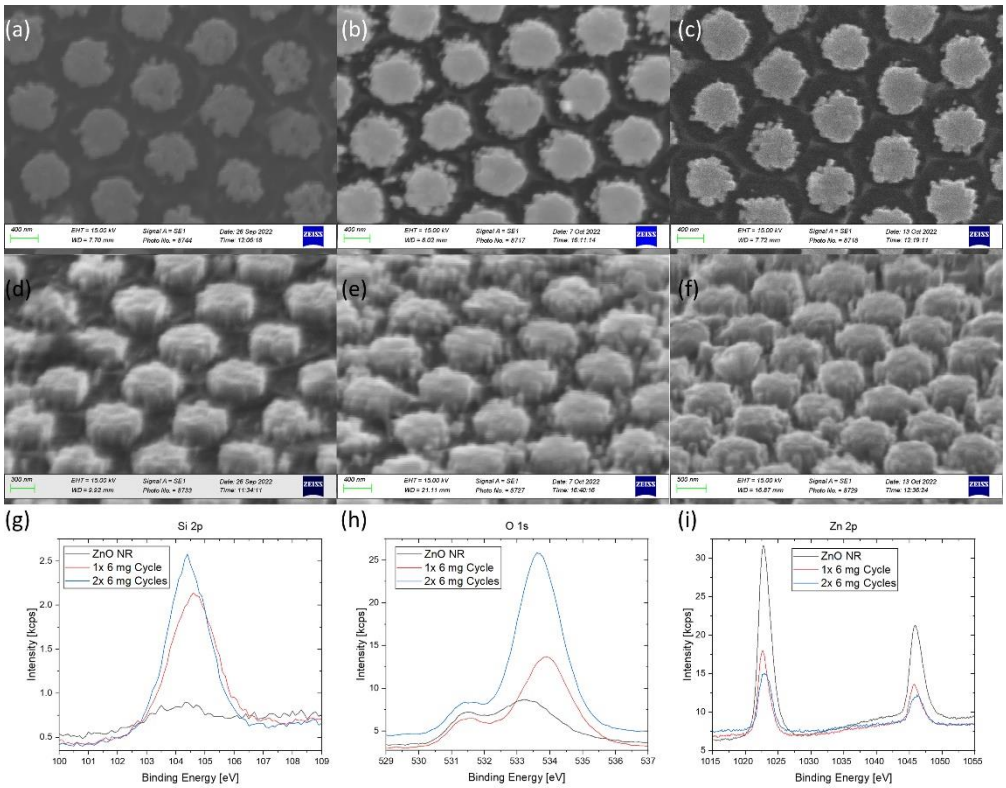

Figure S.6: (a-c) Top-down SEM images of NSL ZnO NR arrays coated in (a) 0 mg, (b) 1x 6 mg cycle, (c) 2x 6 mg cycles. Tilted SEM images (60°) of each are shown below their respective top-down images (d-f). (g-i) XPS spectra of each of the NRs shown in (a-f) with Si 2p intensity in (g), O 1s intensity in (h), and Zn 2 p intensity in (i)

References

[1] D. Byrne, E. McGlynn, J. Cullen, and M. O. Henry, *A Catalyst-Free and Facile Route to Periodically Ordered and c-Axis Aligned ZnO Nanorod Arrays on Diverse Substrates.*, Nanoscale **3**, 1675 (2011).