

Supporting information

## **Structural and Spectroscopic Studies of a Nanostructured Silicon – Perovskite Interface**

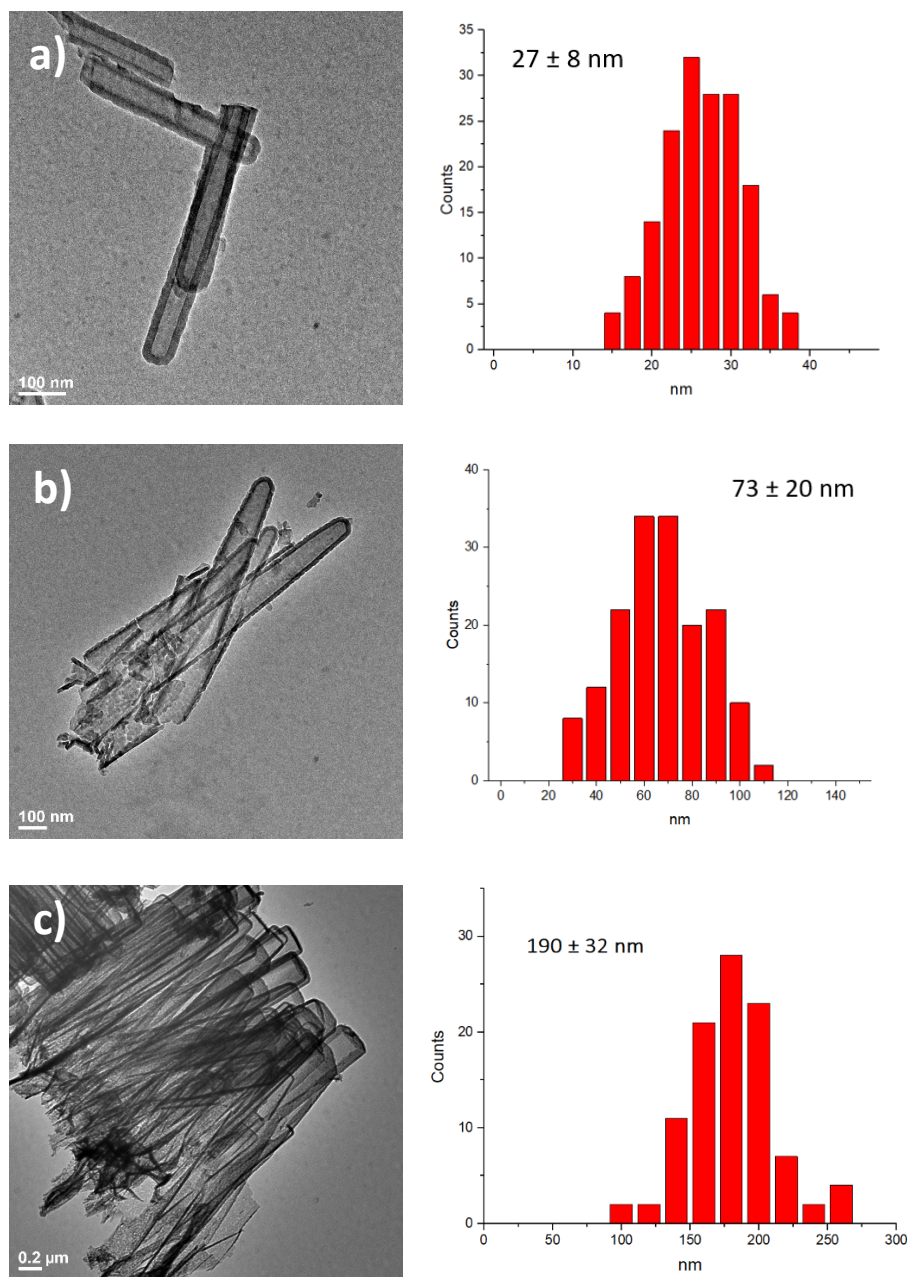
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**Figure S1.** Left column -TEM images / right column – associated histograms of empty Si NTs: a) 30 nm ID Si NTs; b) 70 nm ID Si NTs; c) 200 nm ID Si NTs.

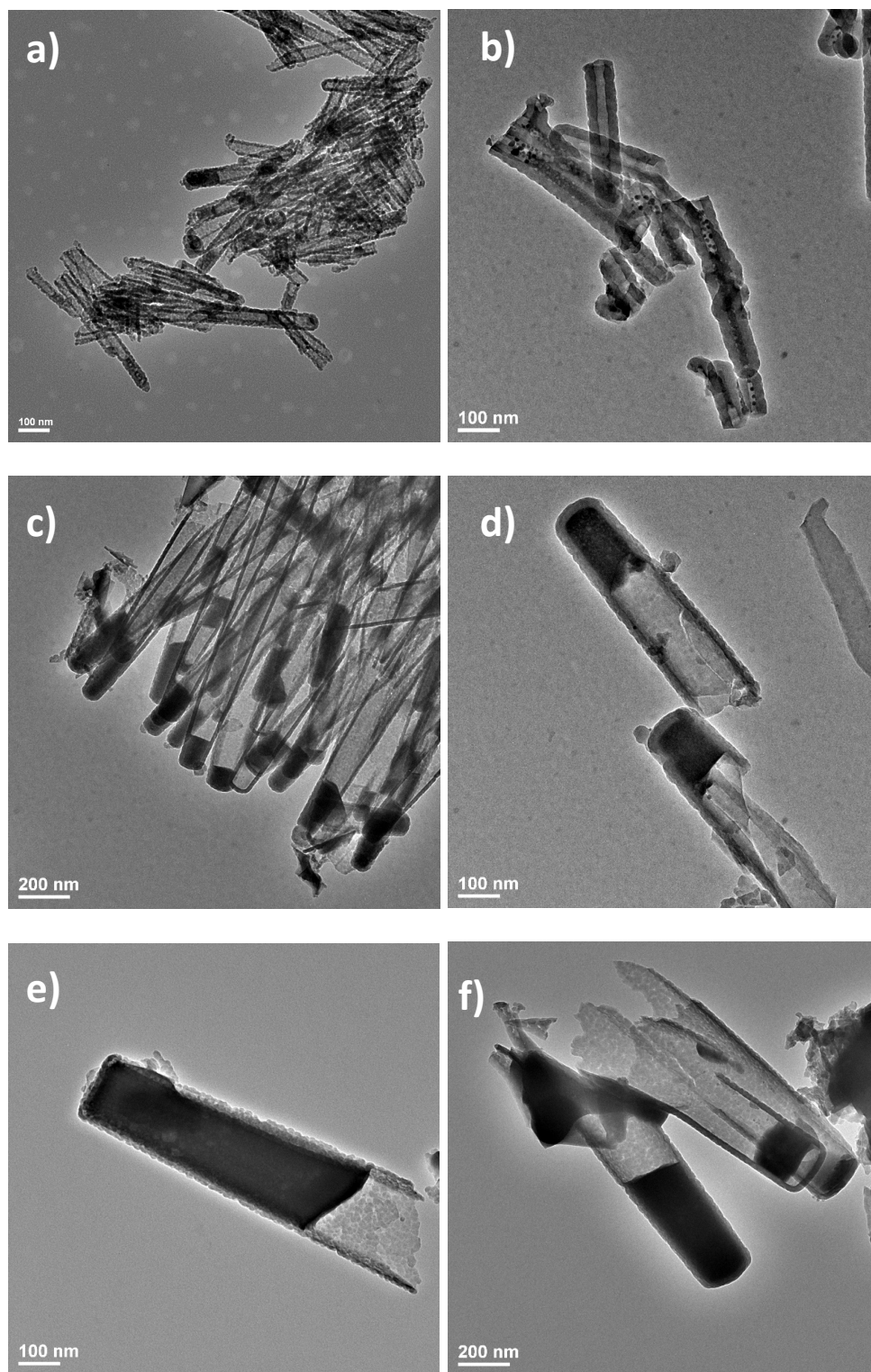
**Table S1.** Compositional information (atomic percent) in the SiNT samples utilized in the perovskite infiltration studies (TEM-EDX).

|                         | Oxygen | Silicon | Lead  | Bromine | Br:Pb | O:Si |
|-------------------------|--------|---------|-------|---------|-------|------|
| 30 nm Si                | 29.94  | 54.68   | 4.58  | 10.79   | 2.35  | 0.54 |
| 30 nm SiO <sub>2</sub>  | 65.35  | 30.63   | 1.03  | 2.99    | 2.90  | 2.13 |
| 70 nm Si                | 25.13  | 55.42   | 4.14  | 15.31   | 3.69  | 0.45 |
| 70 nm Si 1              | 30.5   | 35.66   | 8.17  | 25.66   | 3.14  | 0.85 |
| 70 nm Si 2              | 52.26  | 30.11   | 4.78  | 12.84   | 2.68  | 1.56 |
| 70 nm SiO <sub>2</sub>  | 54.91  | 23.33   | 5.96  | 15.8    | 2.65  | 2.35 |
| 200 nm Si               | 16.74  | 26.34   | 14.66 | 42.27   | 2.88  | 0.63 |
| 200 nm SiO <sub>2</sub> | 43.61  | 23.44   | 9.33  | 23.61   | 2.53  | 1.86 |

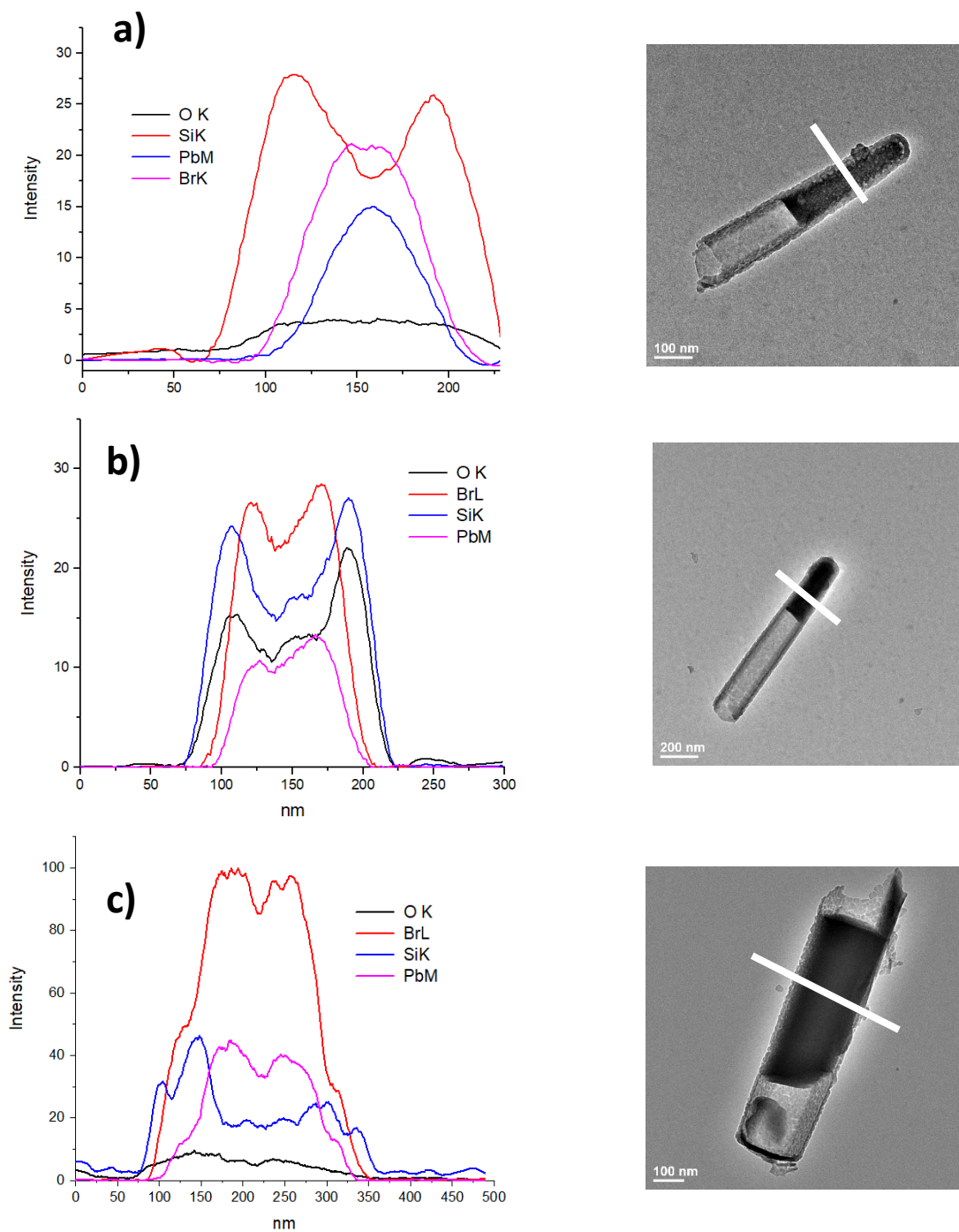
The “x” nm value refers to the inner diameter of a given nanotube composition (e.g. 70 nm Si refers to as-prepared SiNTs with 30 nm inner diameter)

70 nm Si 1 refers to the above SiNT sample with a 70 nm ID that has been annealed in air at 600 °C for 3 hrs.

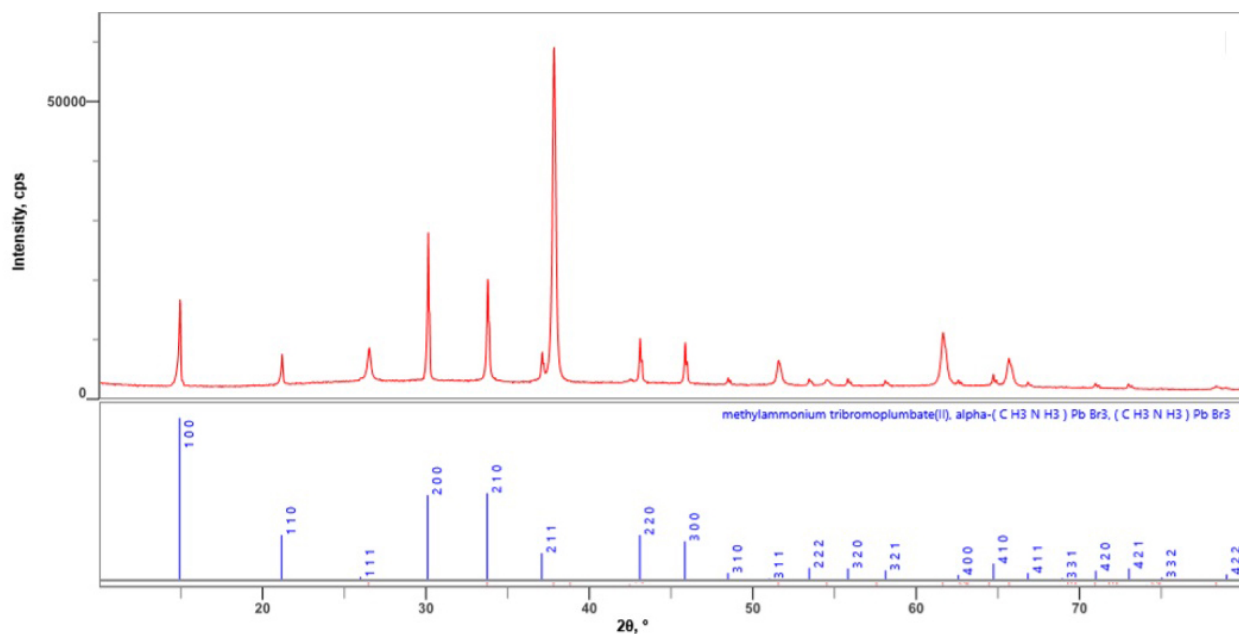
70 nm Si 2 refers to the above SiNT sample with a 70 nm ID that has been annealed in air at 600 °C for 6 hrs.



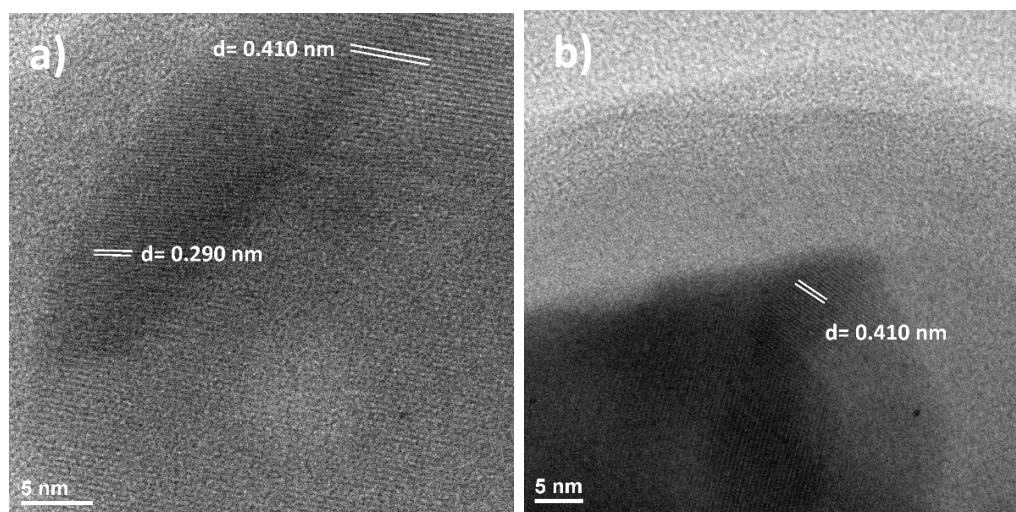
**Figure S2.** TEM images of NTs loaded with MAPbBr<sub>3</sub>: a) 30 nm ID Si NTs; b) 30 nm ID SiO<sub>2</sub> NTs ; c) 70 nm ID Si NTs; d) 70 nm ID SiO<sub>2</sub> NTs; e) 200 nm ID Si NTs; c) 200 nm ID SiO<sub>2</sub> NTs.



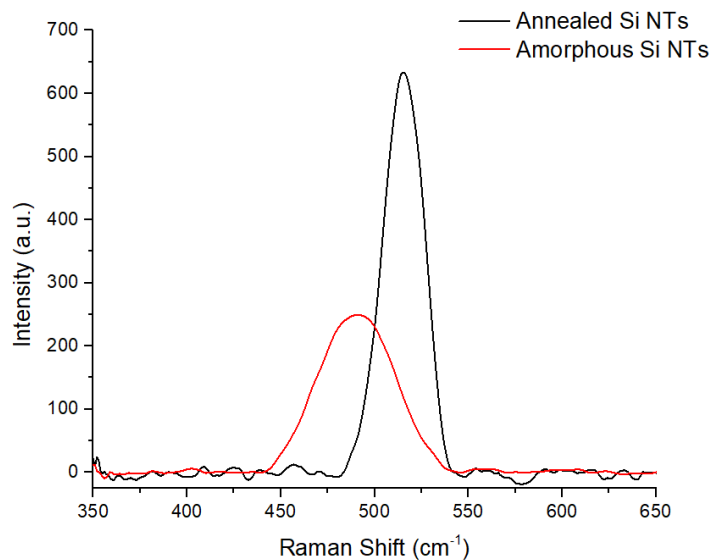
**Figure S3.** TEM-EDX line scan of: a) 70 nm Si NTs with MAPbBr<sub>3</sub>, b) 70 nm SiO<sub>2</sub> NTs with MAPbBr<sub>3</sub> and c) 200 nm ID Si NTs with MAPbBr<sub>3</sub>.



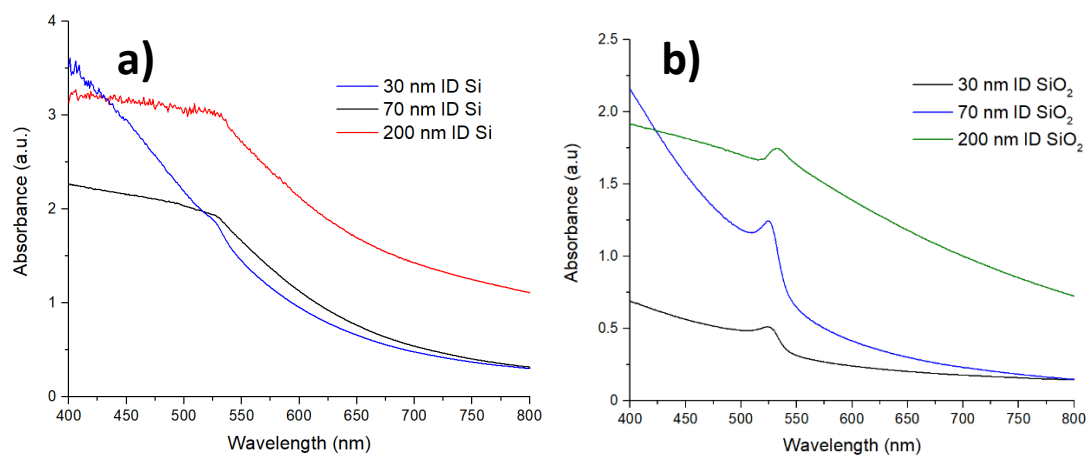
**Figure S4.** X-ray powder diffraction (XRD) spectrum of MAPbBr<sub>3</sub>/SiNT (200 nm ID) film, with reflections associated with the (100), (110), (111), (200), (210), (211), (220), (300), (310), (311), (222), (320), (400) and (410) planes present.



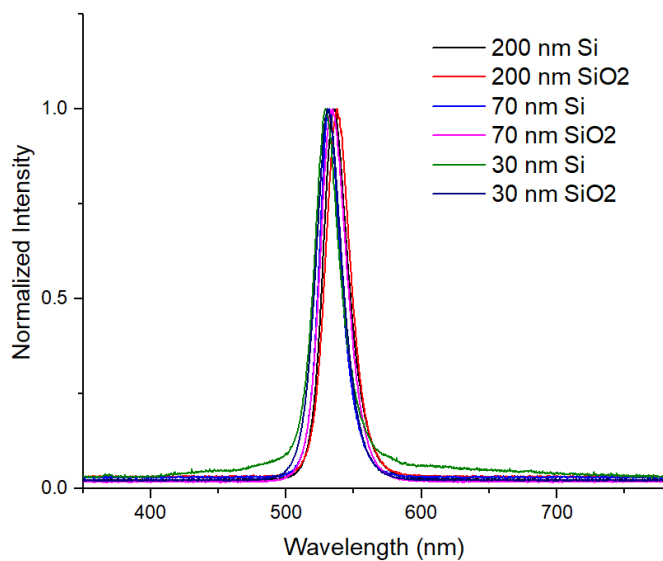
**Figure S5.** (a-b) HRTEM images of MAPbBr<sub>3</sub> loaded in 70 nm ID Si NTs



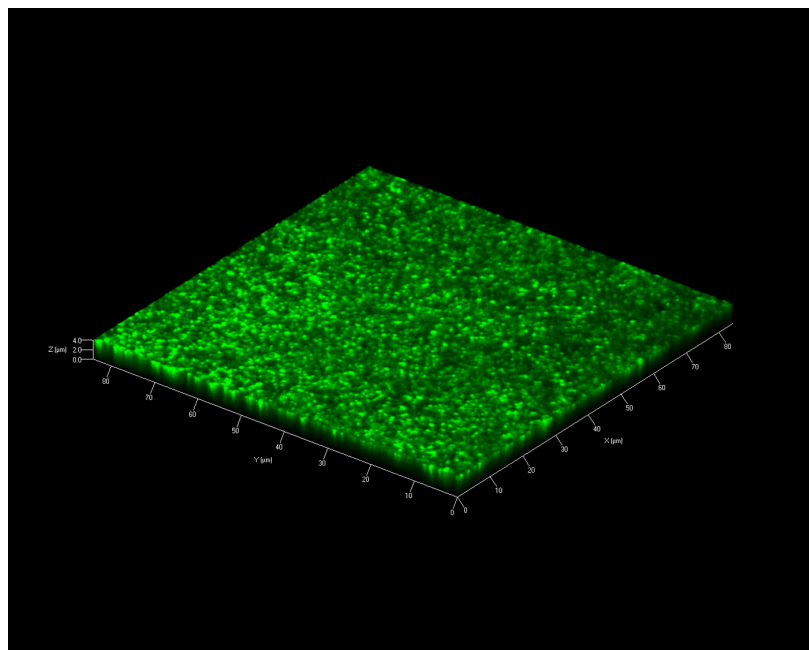
**Figure S6.** Raman spectra of as-formed (amorphous) SiNTs (30 nm ID) as well as the same NT film after annealing at 700°C for 2 hrs in a He atmosphere.



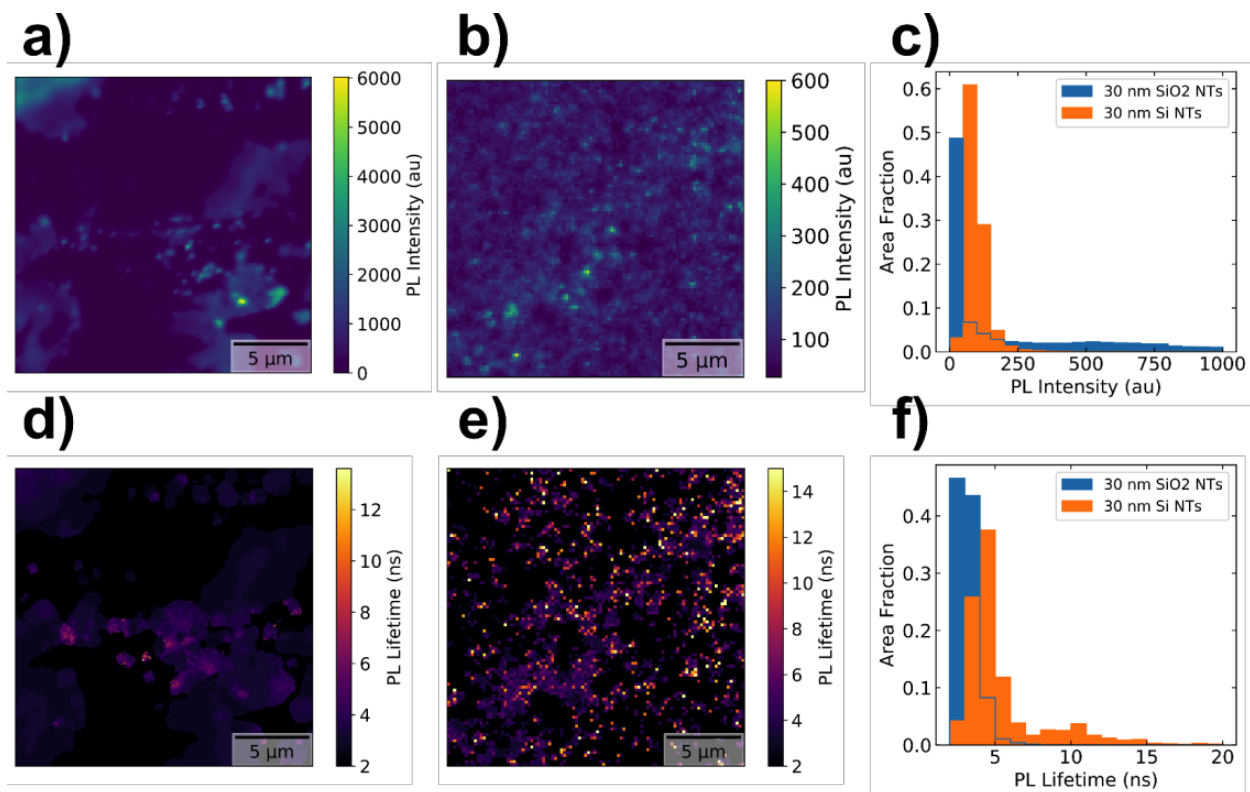
**Figure S7.** Absorption Spectra of: a) Silicon nanotubes loaded with MAPbBr<sub>3</sub>; b) SiO<sub>2</sub> NTs loaded with MAPbBr<sub>3</sub>.



**Figure S8.** Normalized PL spectra for various NT templates loaded with MAPbBr<sub>3</sub> [maximum  $\lambda_{\text{em}}$  at 533 ( $\pm$  3) nm].



**Figure S9.** Confocal PL image of 200 nm ID Si NTs loaded with MAPbBr<sub>3</sub>.



**Figure S10.** a) PL intensity map for MAPbBr<sub>3</sub> housed within 30 nm ID Si NT film. b) PL intensity map for MAPbBr<sub>3</sub> housed within 30 nm ID SiO<sub>2</sub> NT film. c) Histogram of PL intensities extracted from maps shown in panels a and b. d) PL lifetime map for MAPbBr<sub>3</sub> housed within 30 nm ID Si NT film. e) PL lifetime map of MAPbBr<sub>3</sub> housed within 30 nm ID SiO<sub>2</sub> NT film. f) Histogram of PL lifetimes extracted from maps shown in panel d and e.