Online Supplementary Information

Labeling and monitoring the distribution of anchoring sites on functionalized CNTs by atomic layer deposition

Catherine Marichy[1], Jean-Philippe Tessonnier[2], Marta C. Ferro[3], Kyeong-Hwan Lee[4], Robert Schlögl[5], Nicola Pinna[1,4,*], Marc-Georg Willinger[1,5,*]

1 - Department of Chemistry, CICECO, University of Aveiro, 3810-193 Aveiro, Portugal.

2 - Department of Chemical Engineering, University of Delaware, Newark, DE 19716, United States

3 - Department of Ceramics and Glass Engineering, CICECO, University of Aveiro, 3810-193 Aveiro, Portugal.

4 - World Class University (WCU) program of Chemical Convergence for Energy & Environment (C2E2), School of Chemical and Biological Engineering, College of Engineering, Seoul National University (SNU), Seoul 151-744, Korea.

5 - Department of Inorganic Chemistry, Fritz Haber Institute of the Max Planck Society, Berlin, Germany

Corresponding author emails: willinger@fhi-berlin.mpg.de, pinna@ua.pt, pinna@snu.ac.kr

Keywords: Atomic Layer Deposition, Carbon Nanotubes, Surface Functionalization, Nanostructures, Titanium Oxide

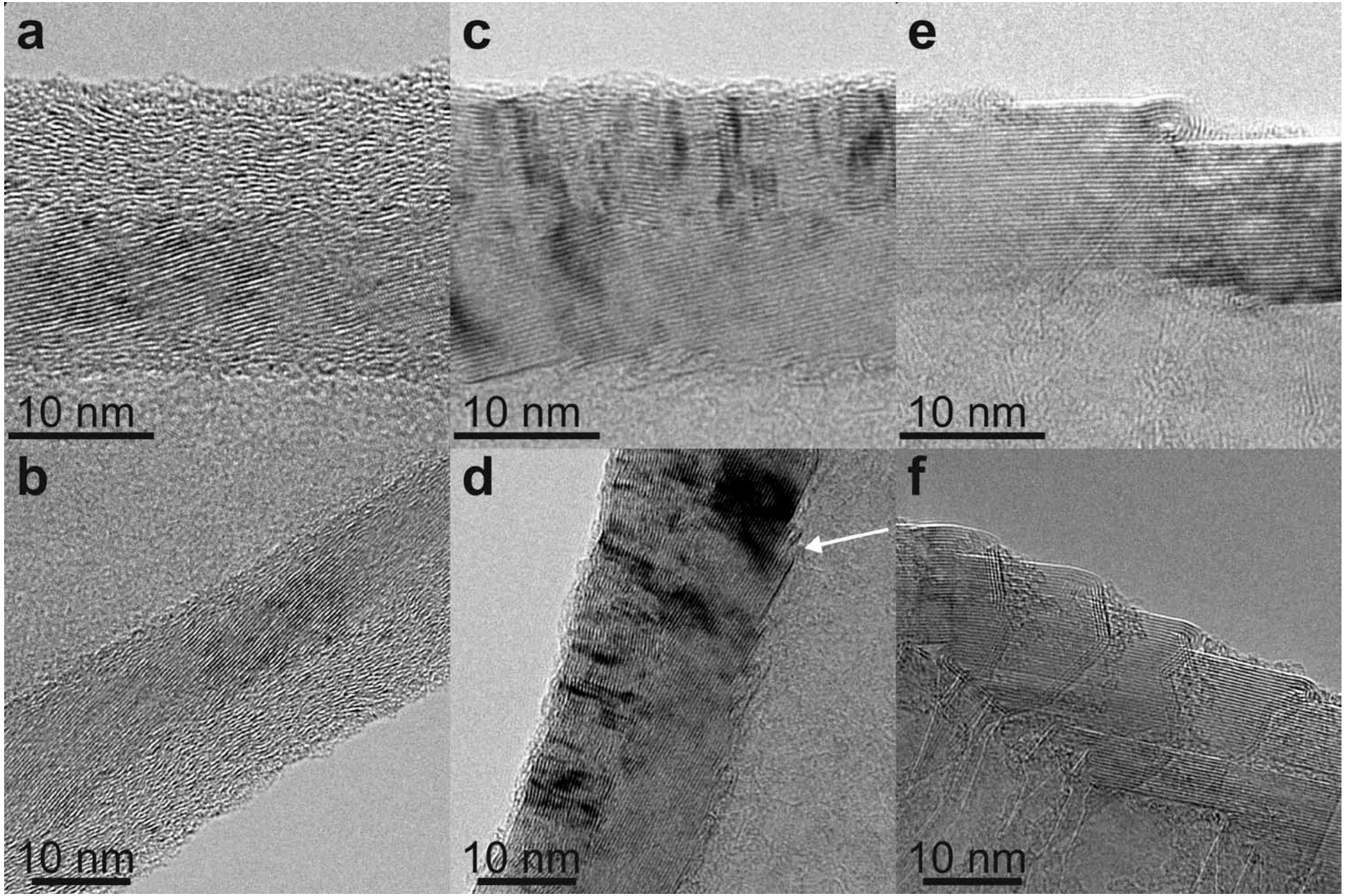

Figure 1. HRTEM images of the different CNTs prior to TiO_2 ALD. CNT700: (a, b), CNT1500: (c, d) and CNT3000, the latter before nitric acid treatment: (e, f).

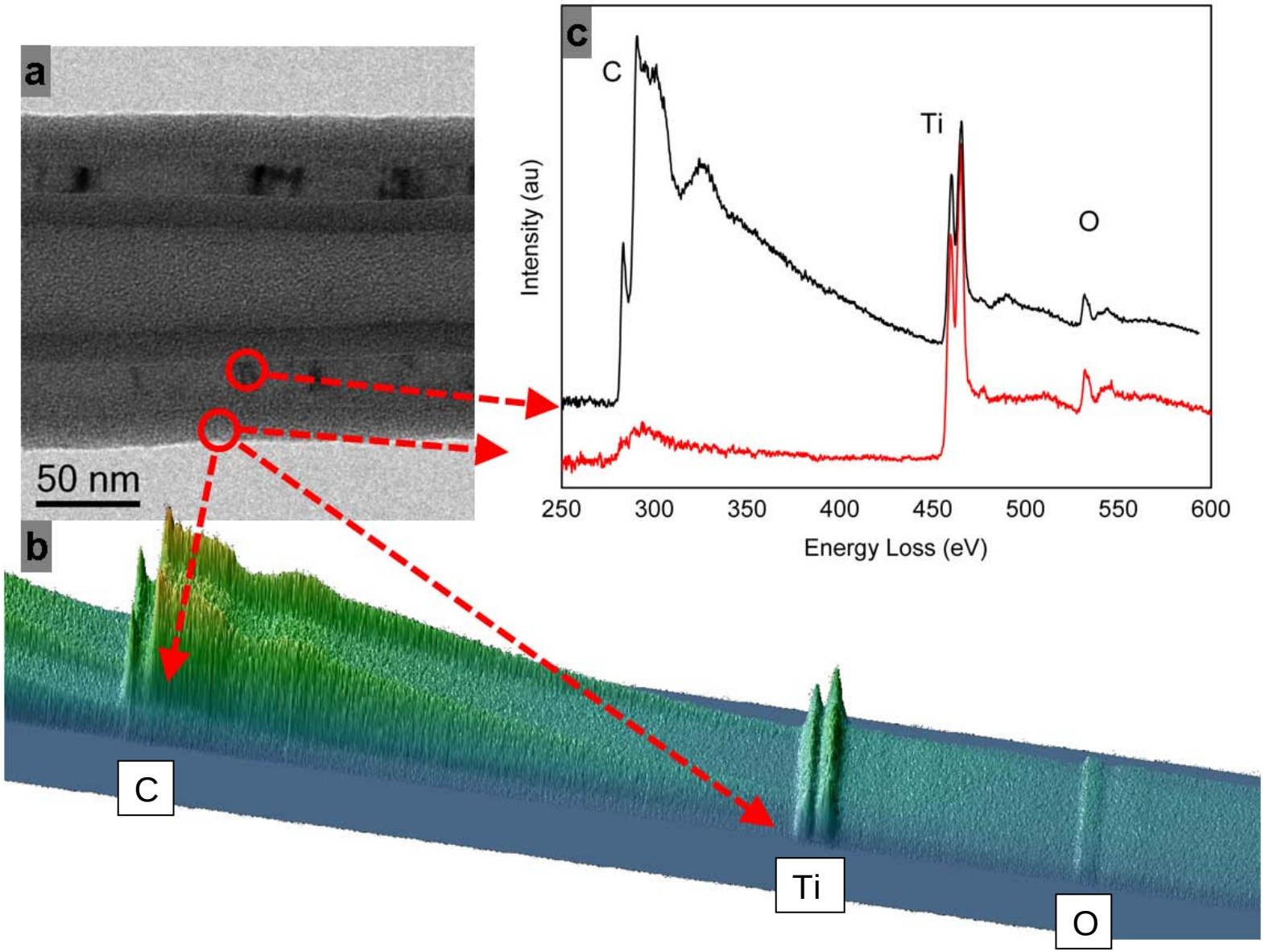

Figure 2. a) Shows the part of a TiO_2 coated CNT from where the EELS signal was recorded (Film thickness ~ 16nm). The recorded intensity is shown in (b) as a three-dimensional plot in the energy dispersive plane. It nicely reveals the development of the C-K, Ti-L and O-K edges across the tube. The EELS spectra abstracted from the coating (red) and from a region where signal is due to the film on the top and bottom surface plus the CNTs walls (black) are shown in (c).

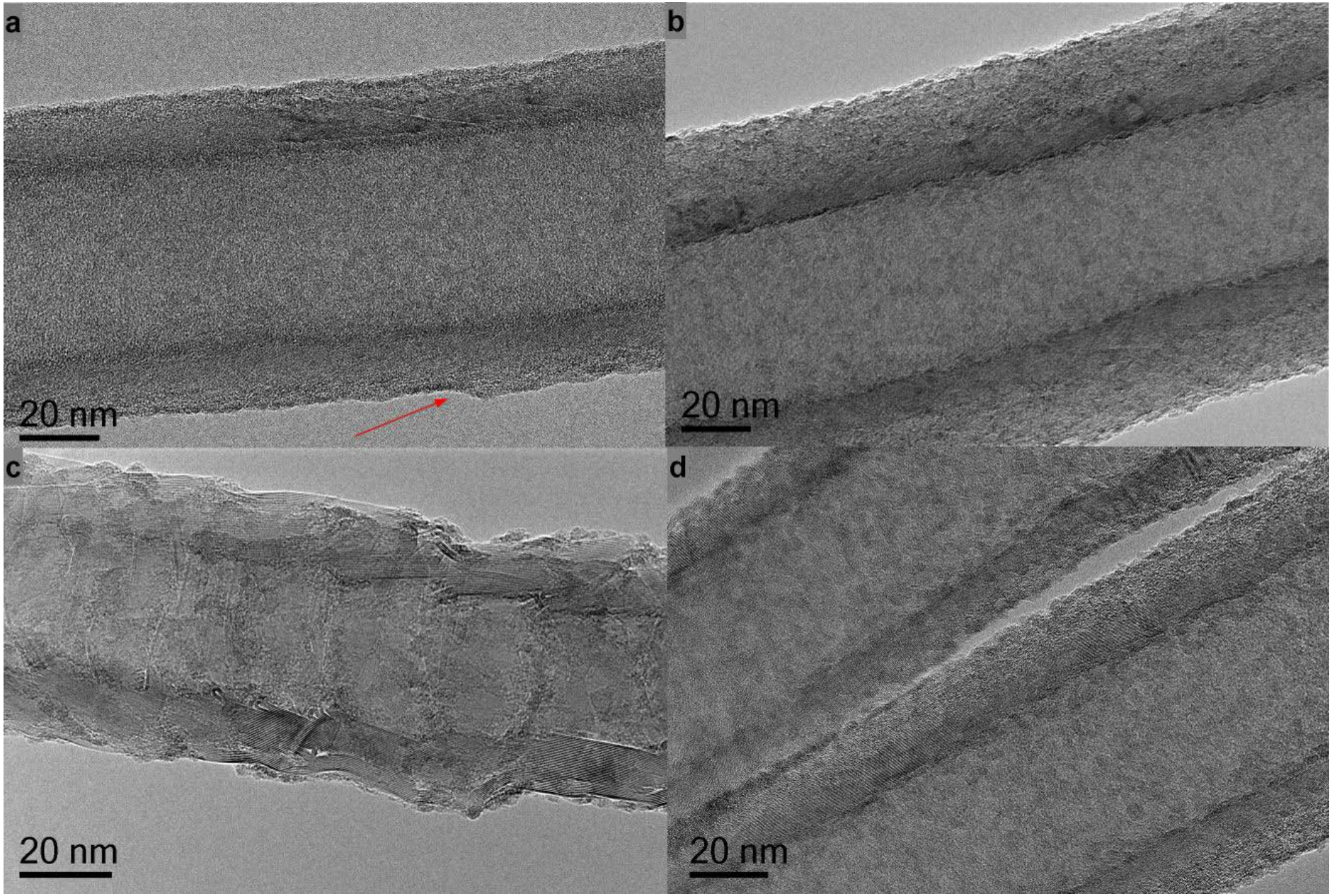

Figure 3. Overview TEM images of CNTs coated with TiO_2 by ALD. (a) CNT700 (100cycles), (b) CNT1500 (50cycles), (c) CNT3000 (50cycles), (d) CNT700D (100cycles).

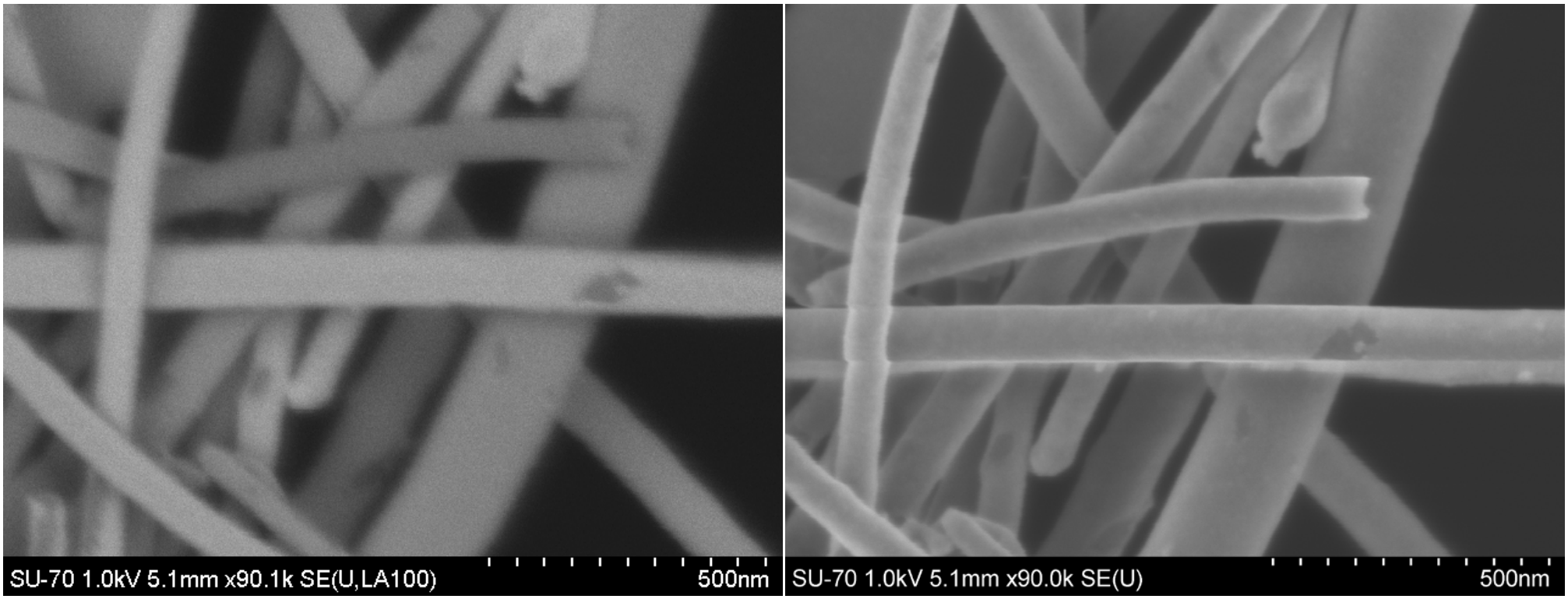

Figure SI1. SEM images of the CNT700 coated with 65 TiO_2 ALD cycles recorded using secondary electrons (left) and backscattered electrons (right)

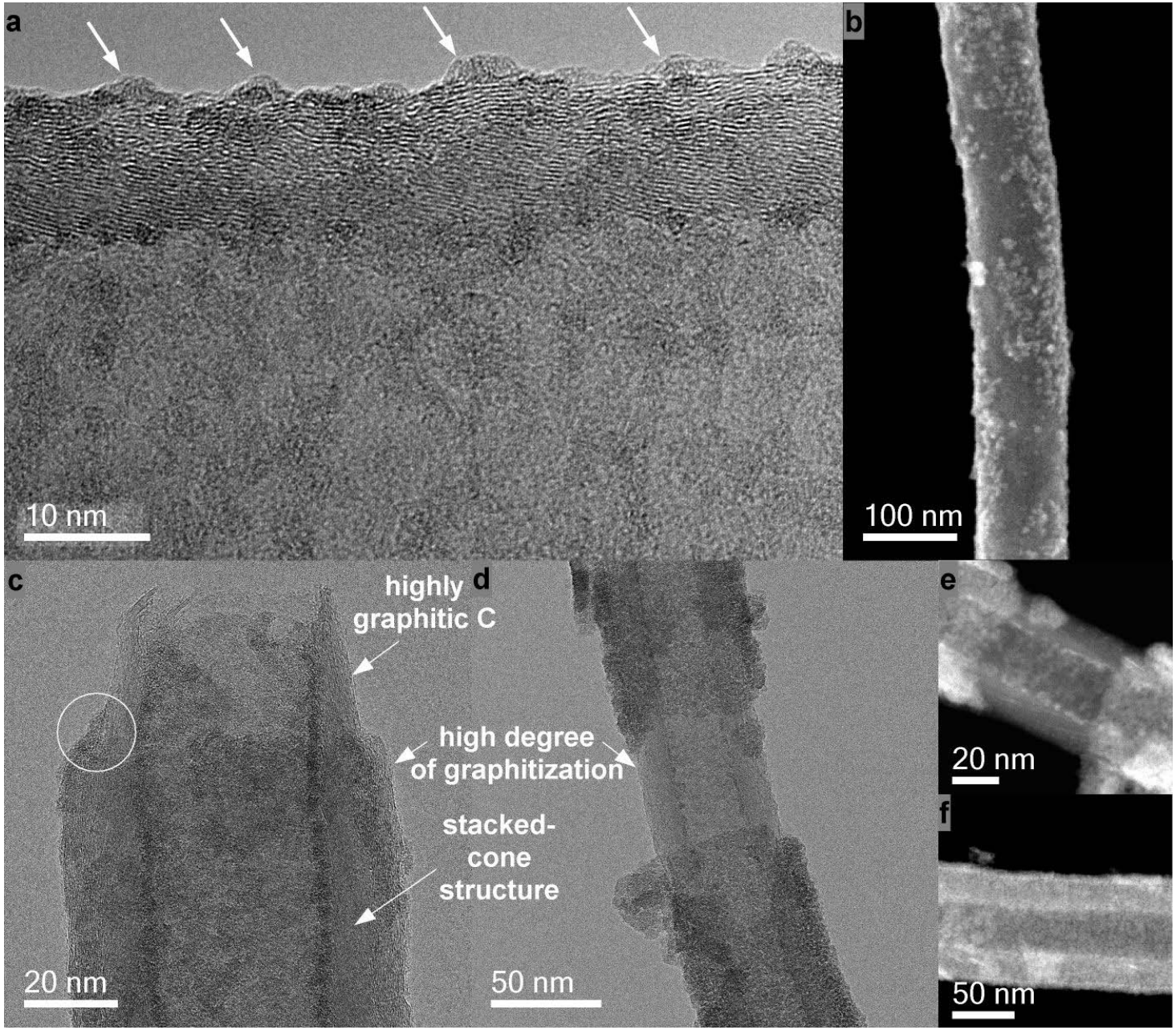

Figure 4. HRTEM (a) and SEM (b) images recorded from the CNT1500 coated during 50 cycles. (c), (d) and (e), (f) show uncoated regions on tubes in HRTEM and HAADF-STEM images recorded from tubes coated during 100 cycles.

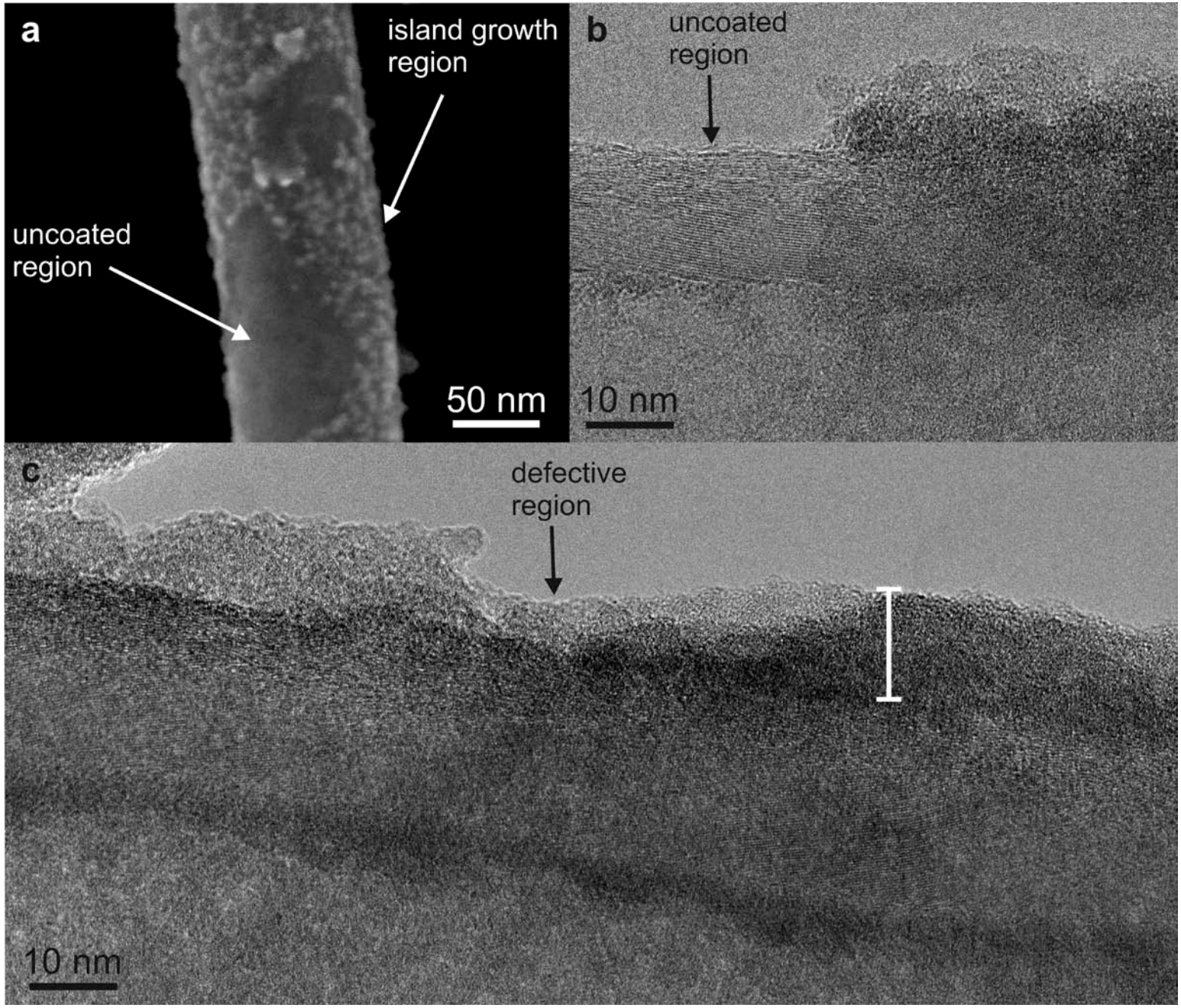

Figure SI2. (a) HRSEM image recorded from the CNT1500 coated during 50 cycles. HRTEM images recorded from tubes coated during 100 (b) and 500 (c) cycles.

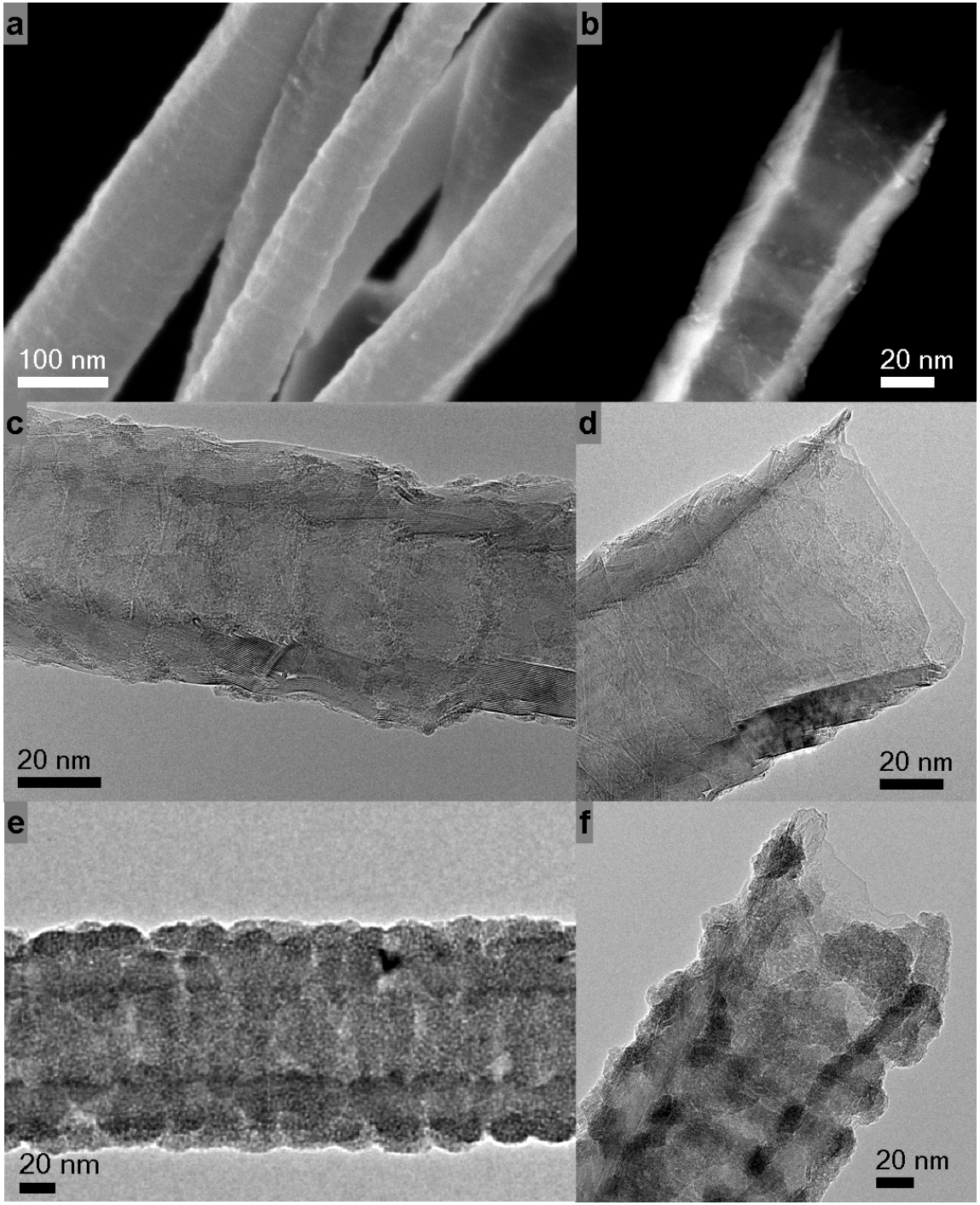

Figure 5. (a) SEM, (b) HAADF-STEM, (c,d) HRTEM and (e,f) TEM images of the CNT3000 coated with (b) 25, (a,c,d) 50 and (e,f) 500 TiO_2 ALD cycles.

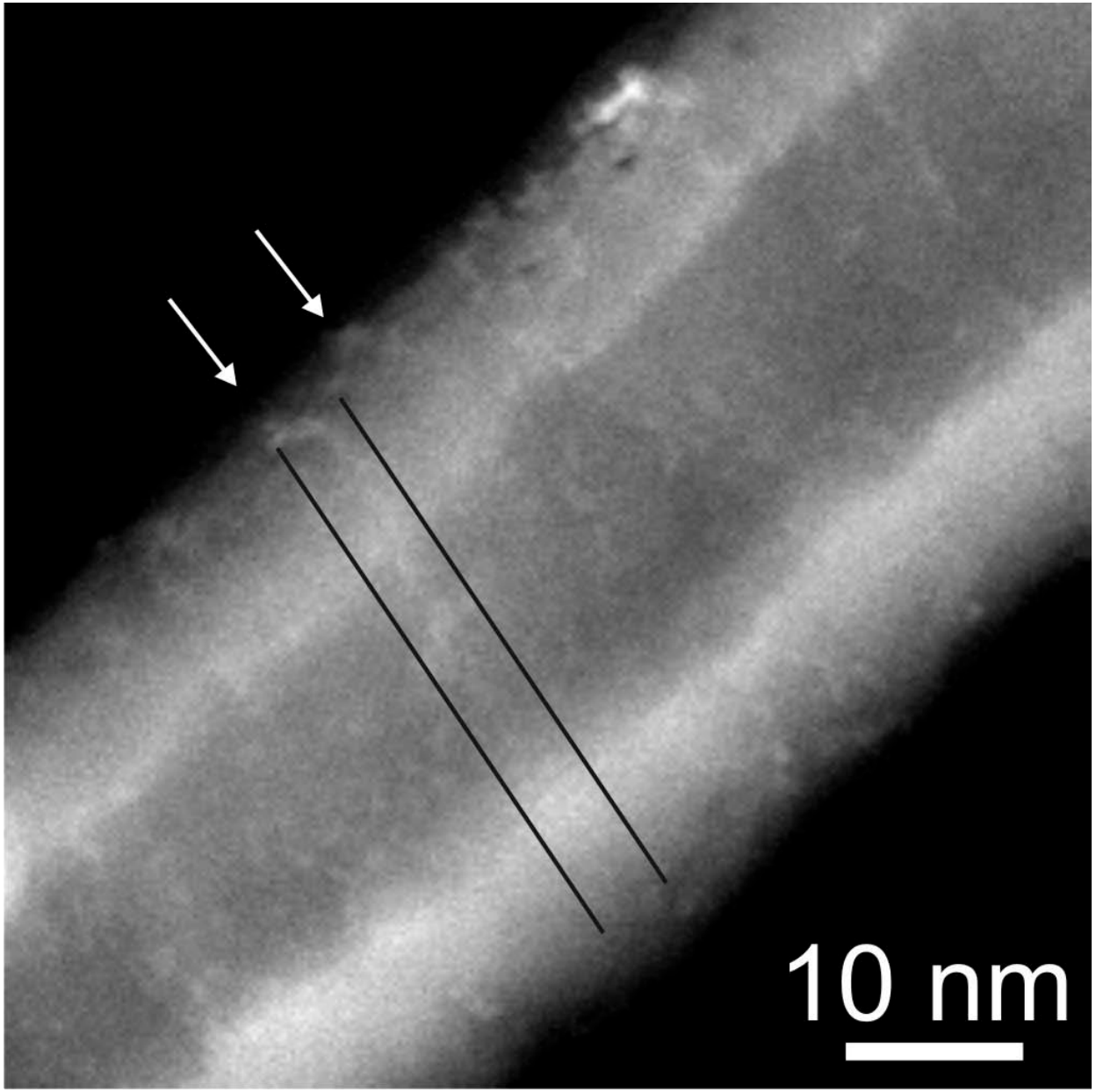

Figure SI3. HAADF-STEM image of the CNT3000 coated with 25 TiO_2 ALD cycles

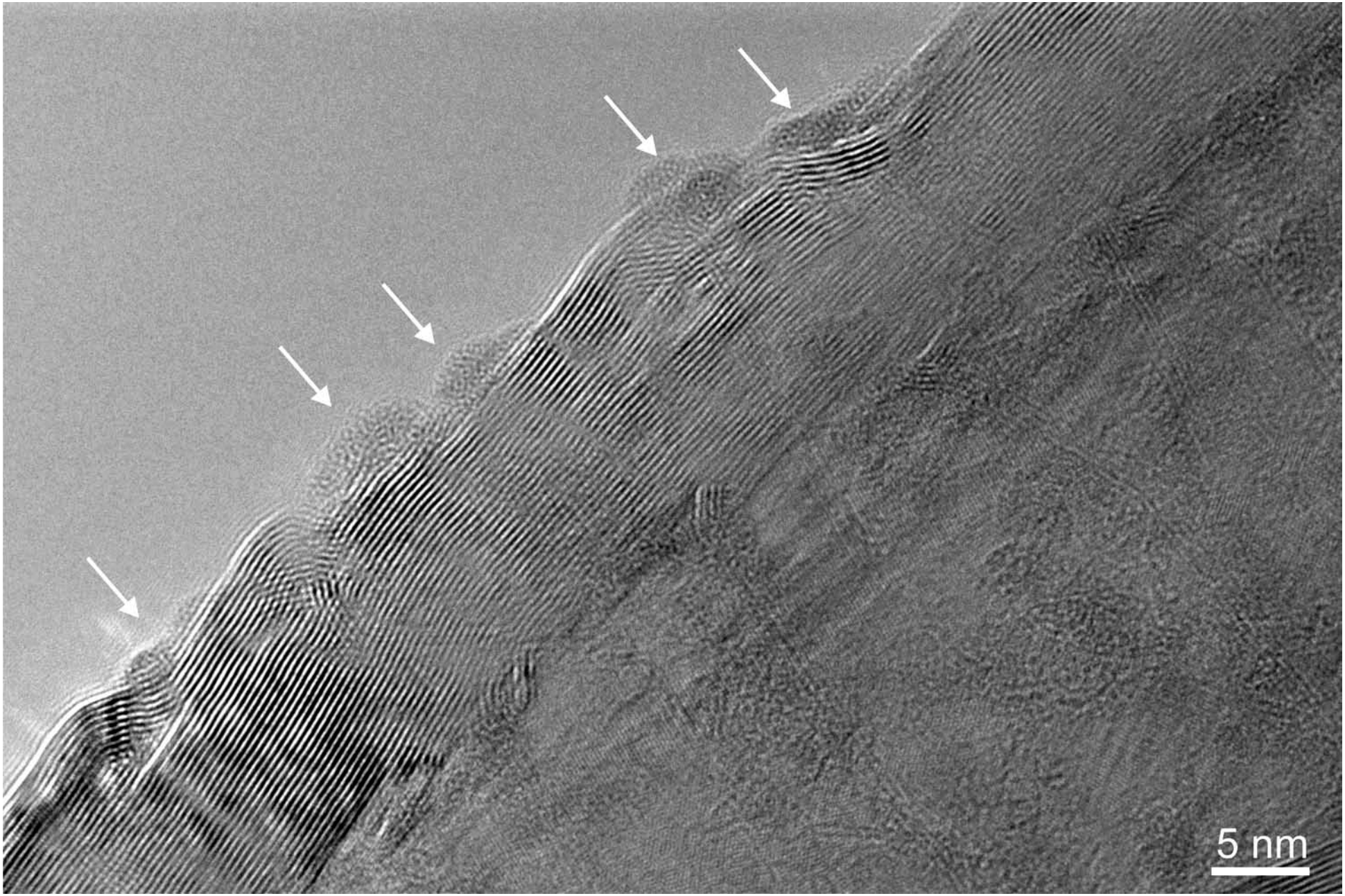

Figure SI4. HRTEM image of the CNT3000 coated with 50 TiO_2 ALD cycles

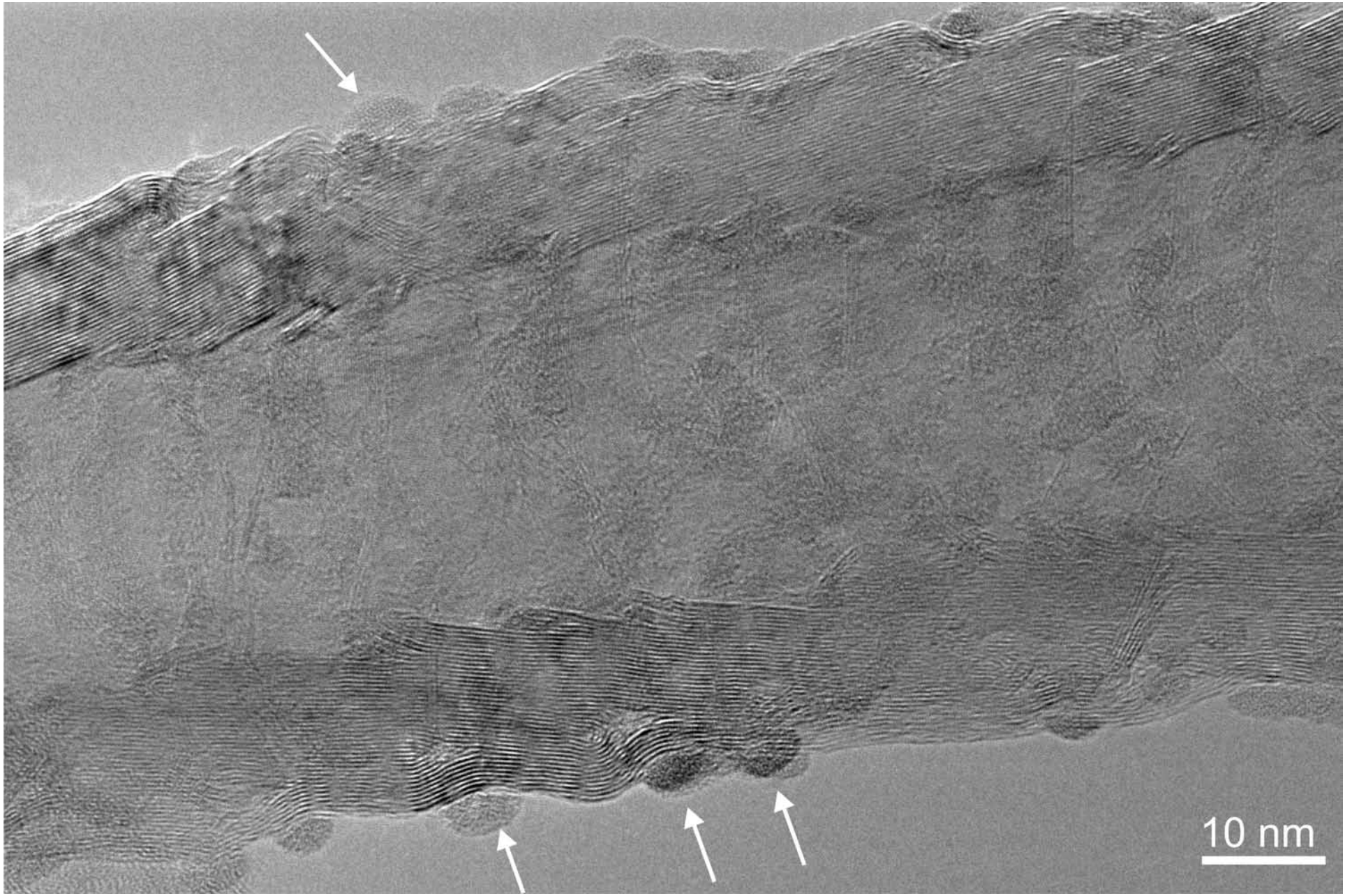

Figure SI5. HRTEM image of the CNT3000 coated with 50 TiO_2 ALD cycles

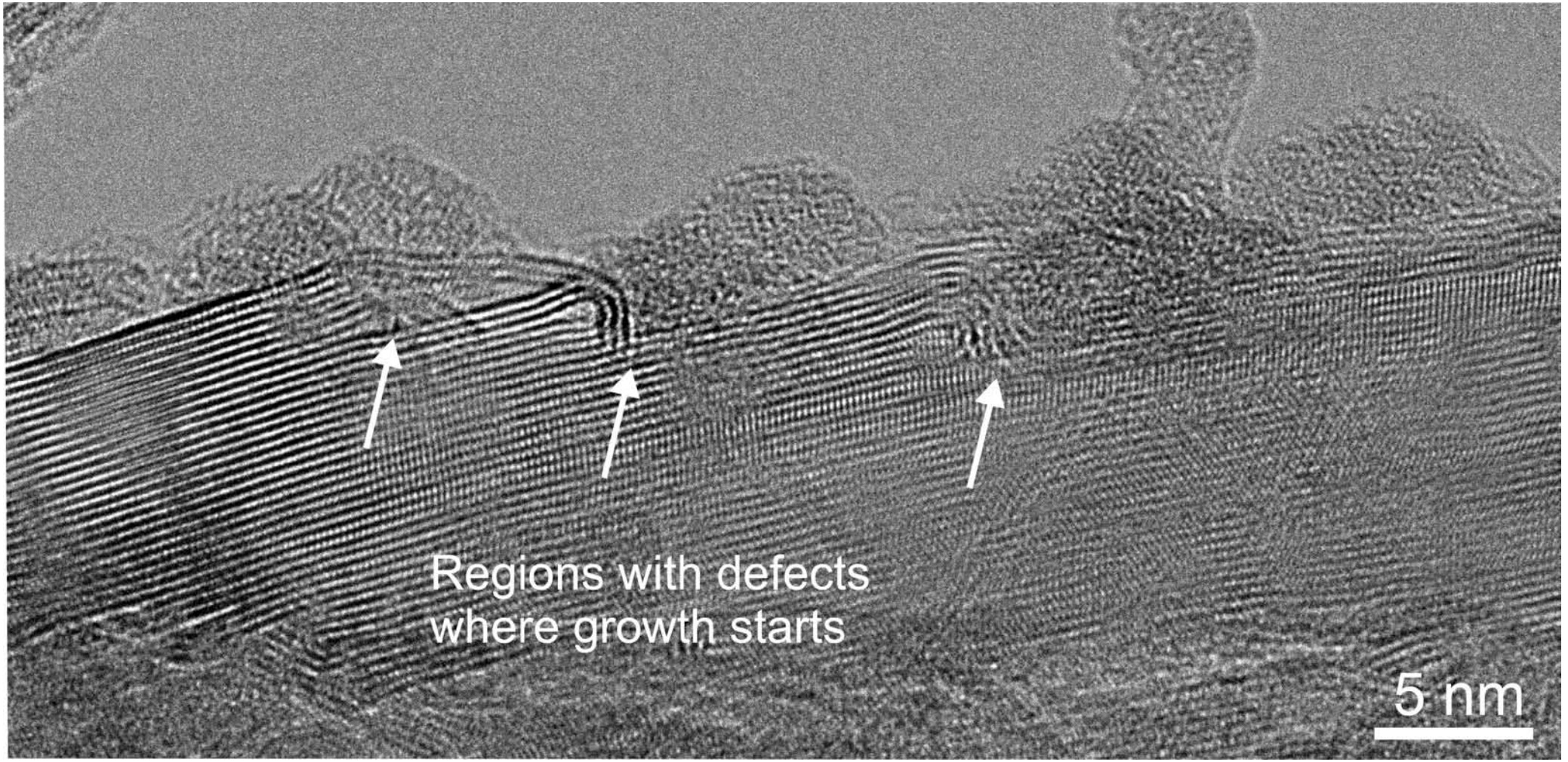

Figure SI6. HRTEM image of the CNT3000 coated with 100 TiO_2 ALD cycles

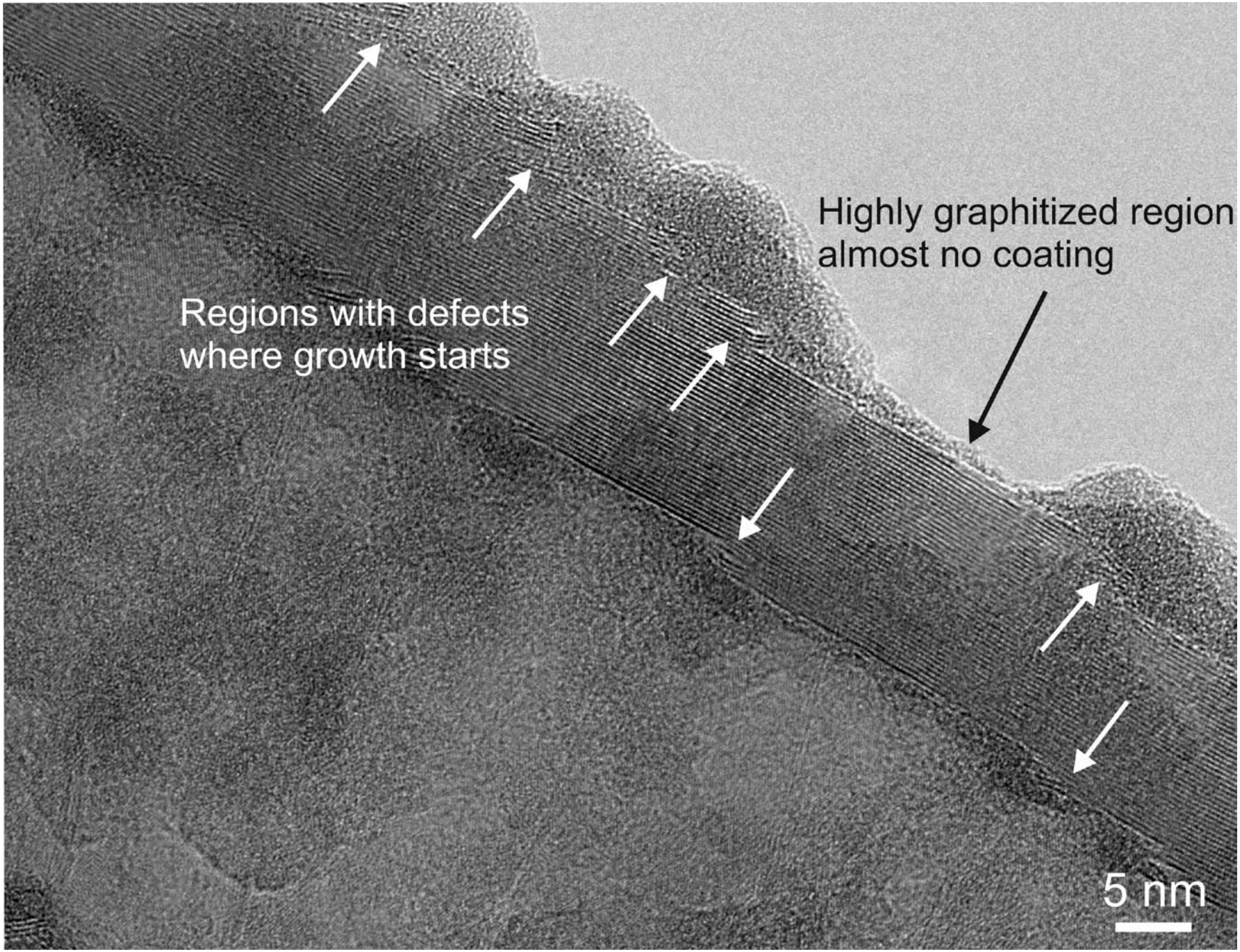

Figure SI7. HRTEM image of the CNT3000 coated with 500 TiO_2 ALD cycles

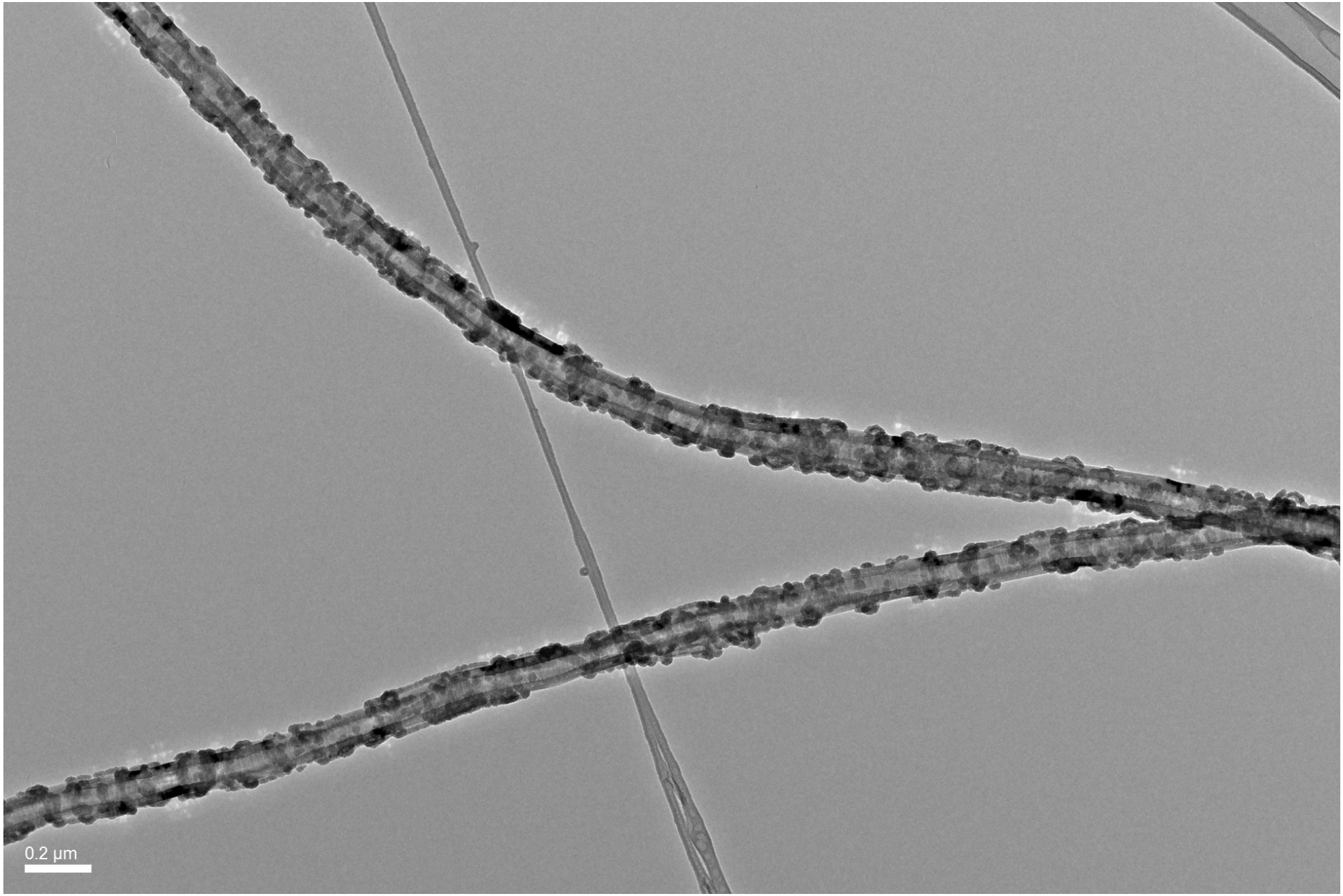

Figure SI8. Low resolution TEM image of the CNT3000 coated with 500 TiO_2 ALD cycles showing the nucleation at defect sites which is comparable at different region of the CNT3000.

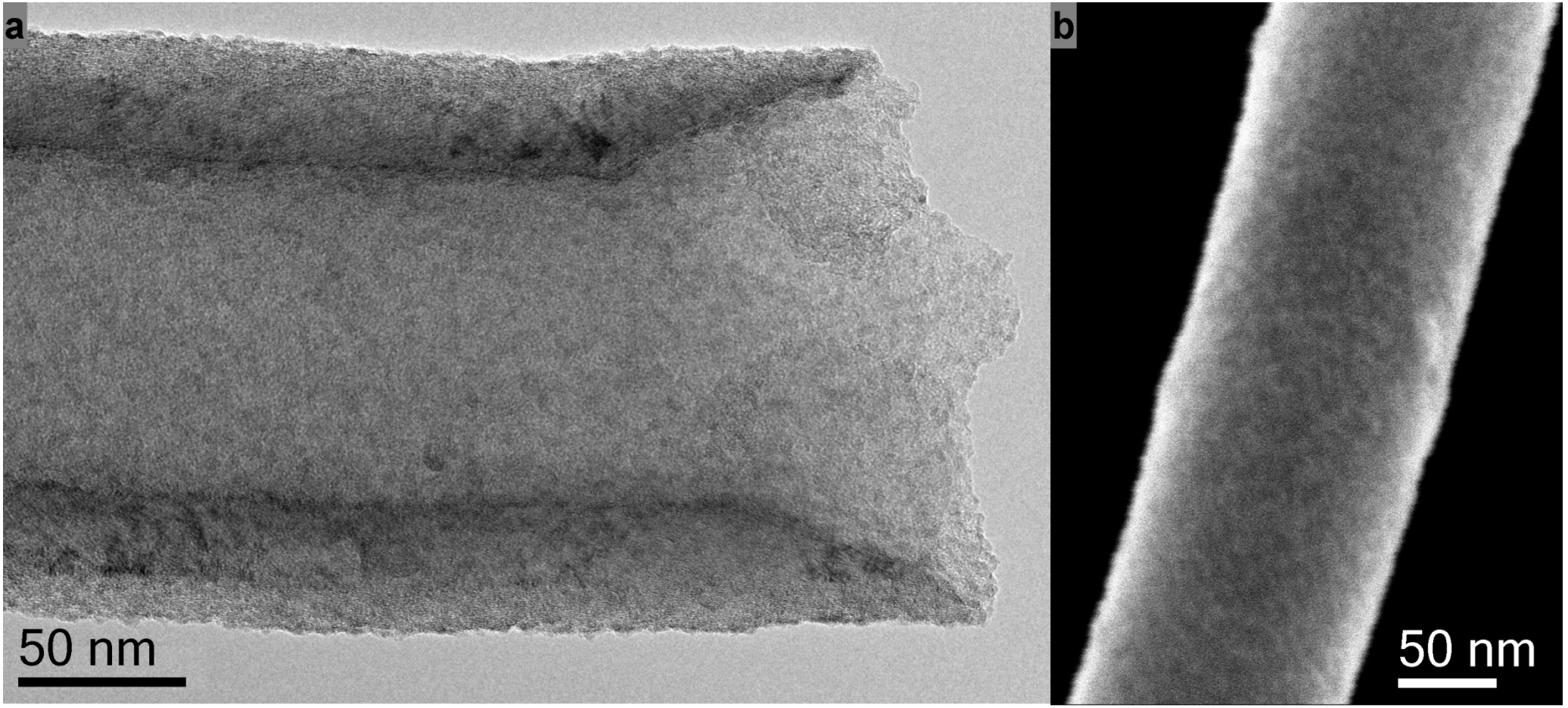

Figure 6. HRTEM (a) and SEM (b) images of CNT700D coated with 50 TiO_2 ALD cycles.

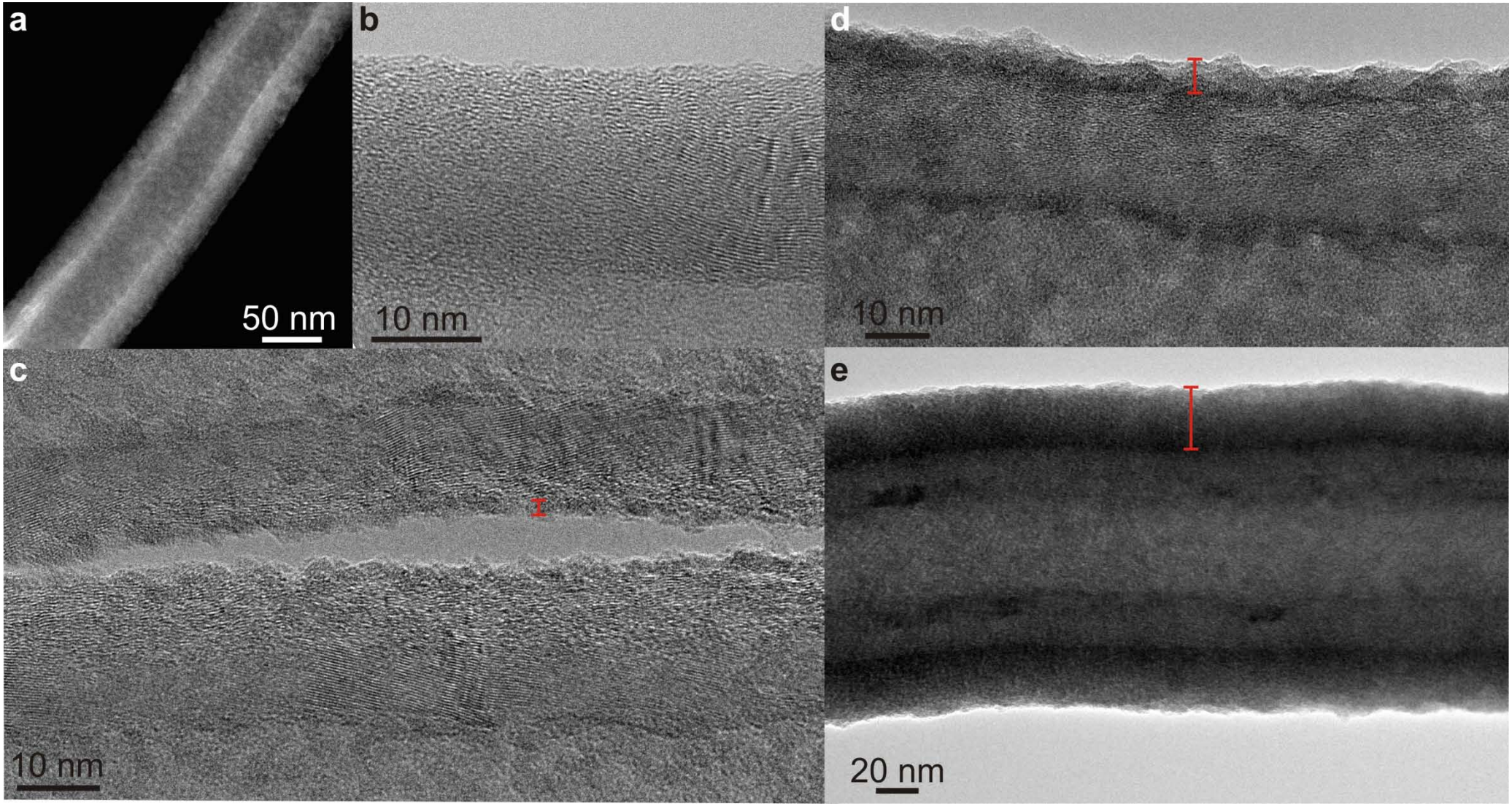

Figure SI9. a) HAADF-STEM image of CNT700D coated with 100 TiO_2 ALD cycles. HRTEM images of CNT700D coated with 0 (b), 100 (c), 500 (d) and 1000 (e) TiO_2 ALD cycles. N.B. in (c) two neighboring tubes are imaged.

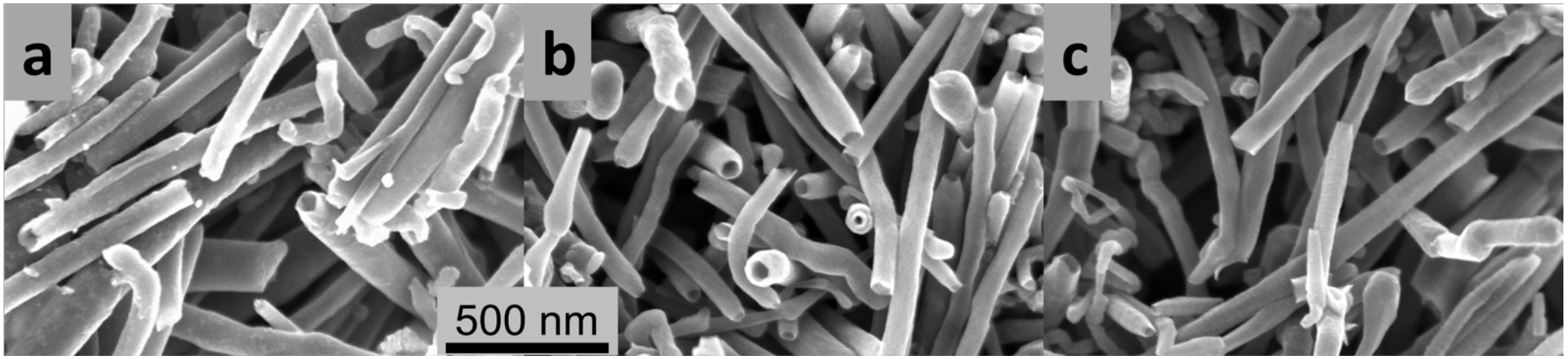

Figure SI10. SEM images of the uncoated CNT700 (a), CNT1500 (b) and CNT3000 (c)

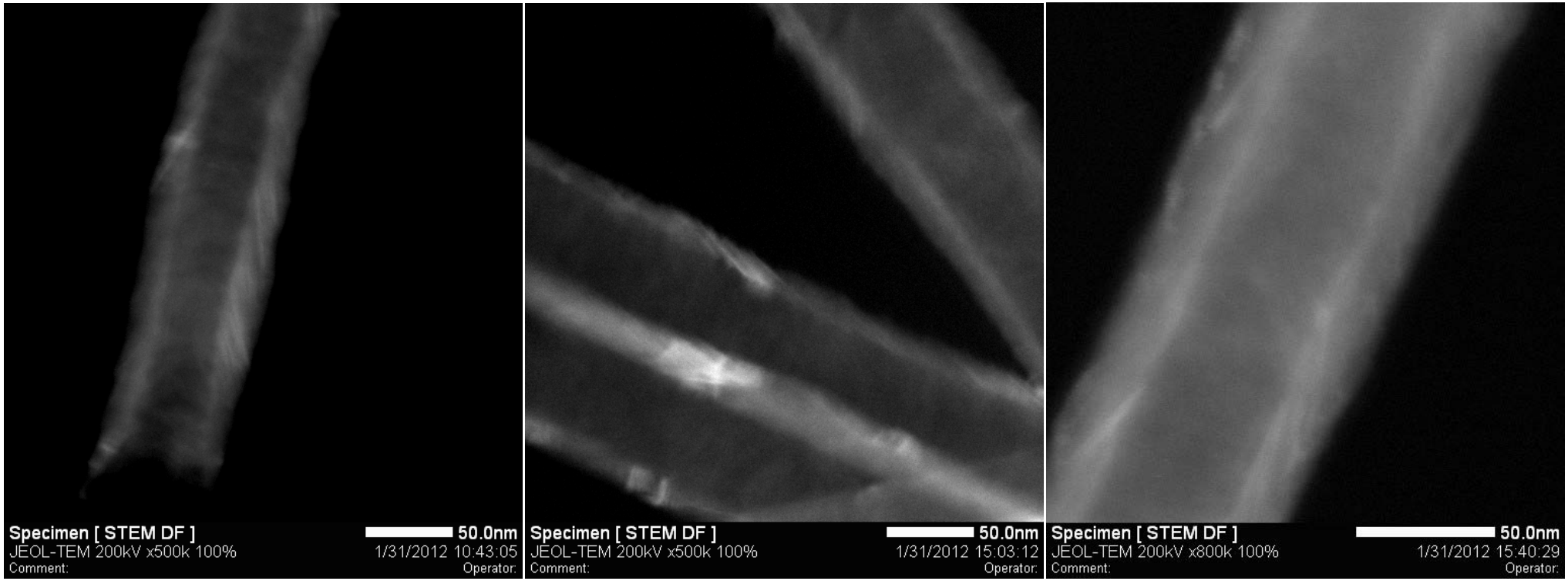

Figure SI11. HAADF-STEM images of the uncoated CNT3000