Electronic Supplementary Material (ESI) for RSC Advances

Supplementary Information

High Rate Capacity Retention of Binder-free, Tin Oxide Nanowire Arrays Using Thin Titania and Alumina Coatings

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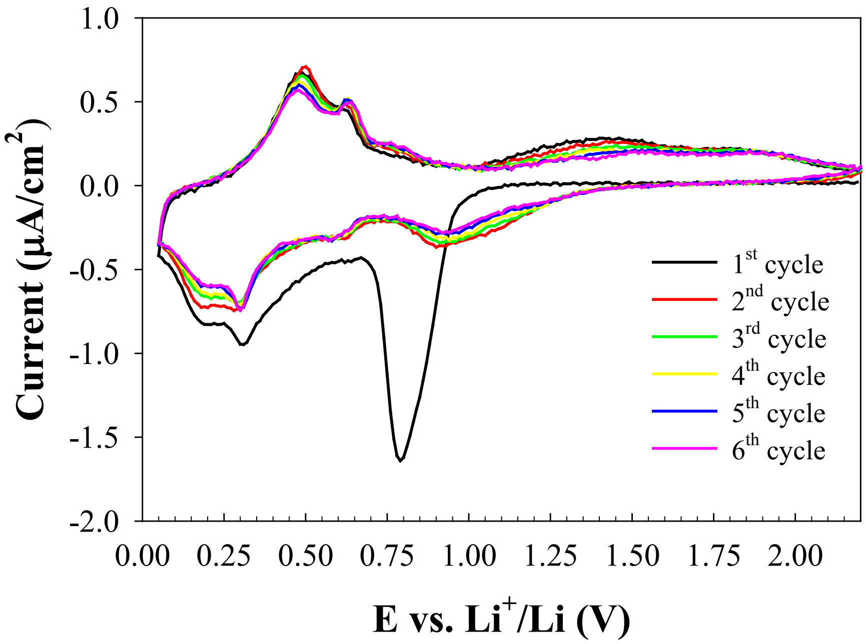

Fig. S1: Cyclic voltammetry of SnO_2 NWs at the voltage range of 2.2 ÷ 0.005 V using scan speed of 5 mV/min

Table S1: 1st cycle electrochemical performance comparison of pure SnO_2 NWs and titania-coated SnO_2 NWs

Sample	Discharge capacity, $mAhg^{-1}$	Charge capacity, $mAhg^{-1}$	Columbic efficiency, %	ICL, $mAhg^{-1}$	ICL due to reduction of tin oxide to tin, $mAhg^{-1}$	ICL due to SEI formation, $mAhg^{-1}$
Pure SnO_2 NWs	1680	832	49.5	848	400	448
titania-coated SnO_2	1705	1238	72.6	467	520	-

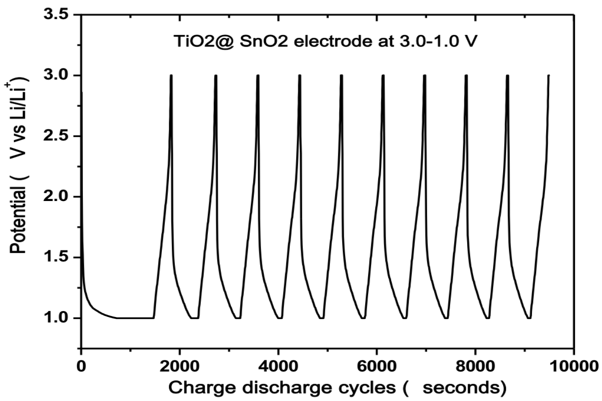

Fig. S2: The charge-discharge capacities with times vs. voltage profiles of titania-coated SnO_2 NWs electrode at 3.0-1.0 V

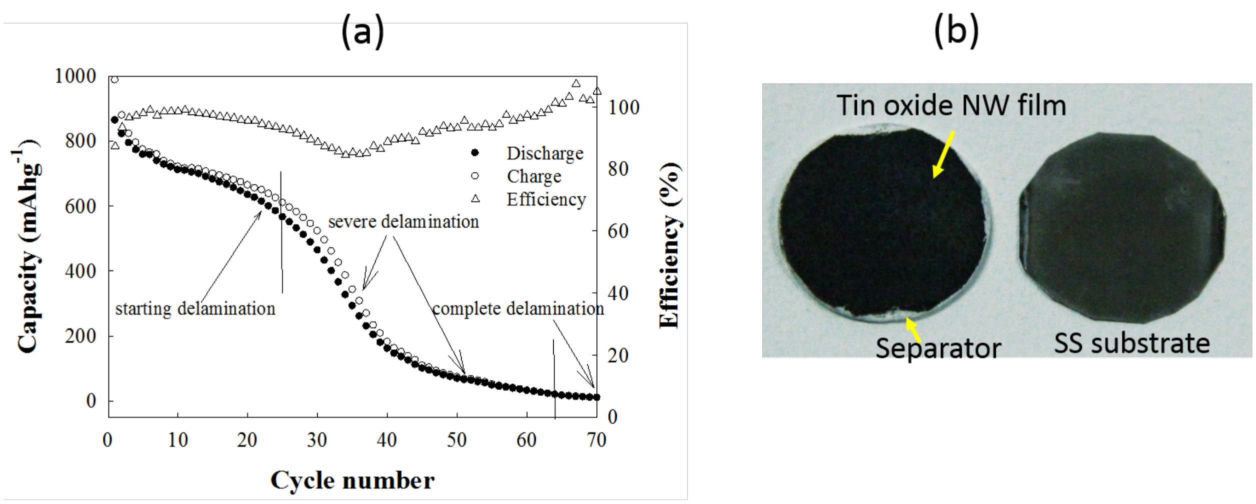

Fig. S3: (a) Charge and discharge capacities vs. cycle number of titania-coated SnO_2 NWs at current density of 1500 mA/g; (b) the photograph of delaminated electrode: the tin oxide film (black in color) was completely delaminated from stainless substrate and adhered onto the separator (white in color).

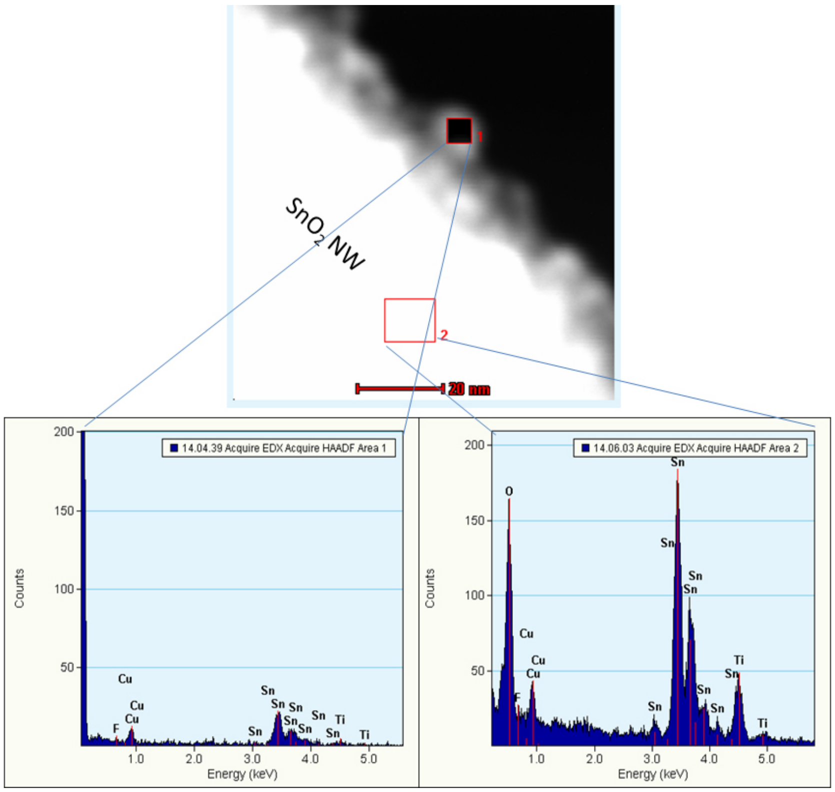

Fig. S4: EDS data of 15 nm titania-coated SnO_2 NWs after cycling

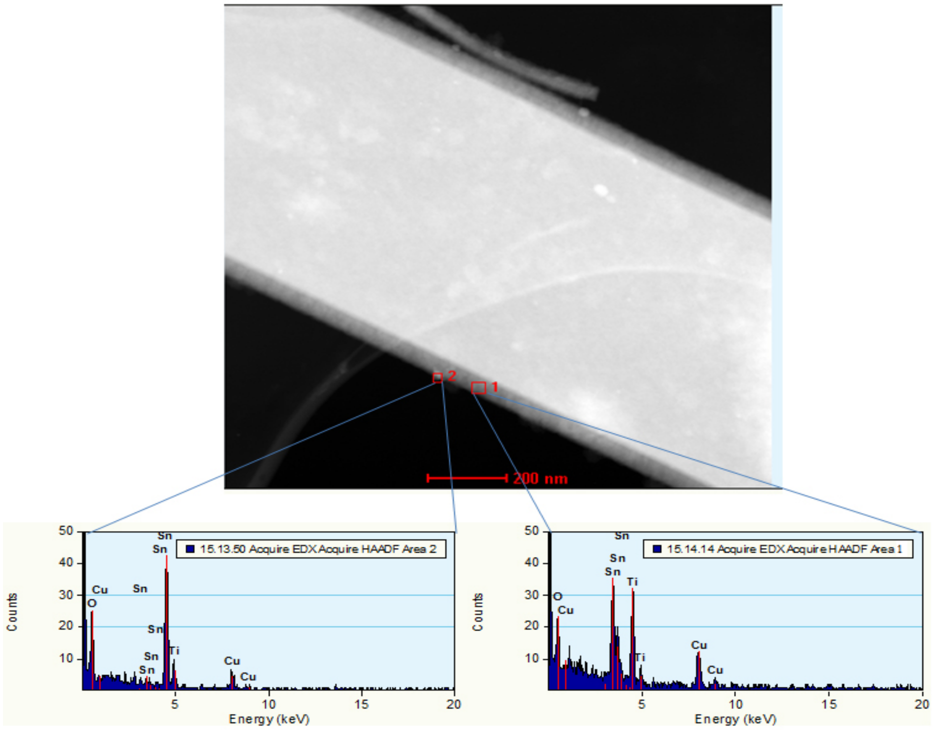

Fig. S5: EDS data of titania-coated SnO_2 NWs after cycling at votage of 1.0 – 3.0V

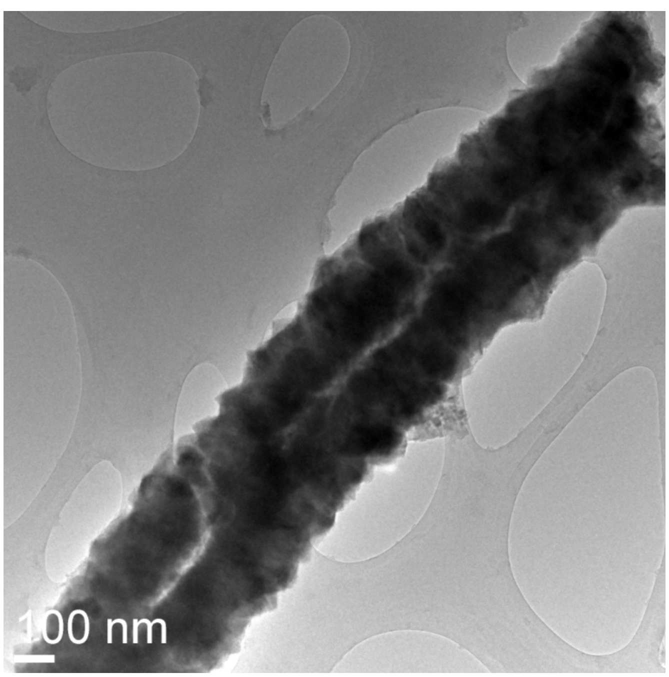

Fig. S6: TEM image of titania-coated SnO_2 NWs after cycling at showing nanowire morphology with hollow structure

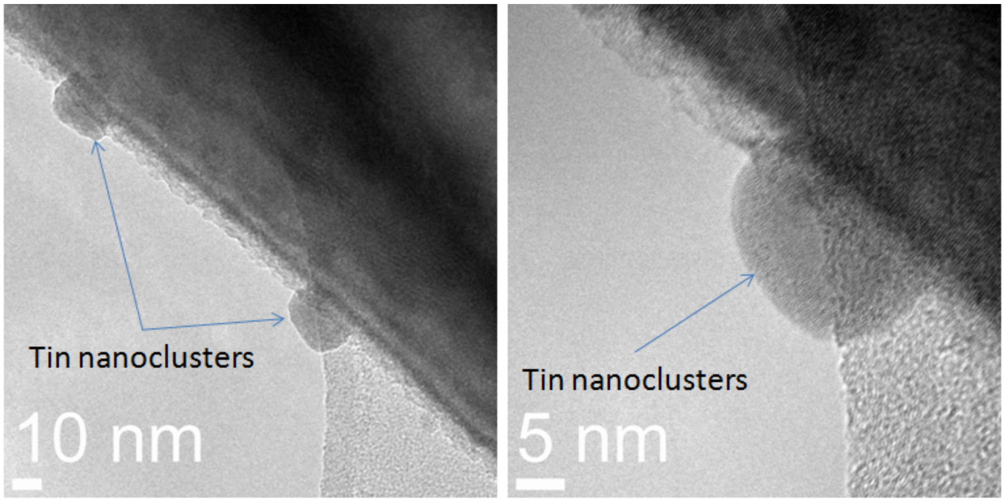

Fig. S7: HR-TEM of titania-coated SnO_2 NWs after 1^{st} cycle showing presence of tin nanoclusters on nanowire surface

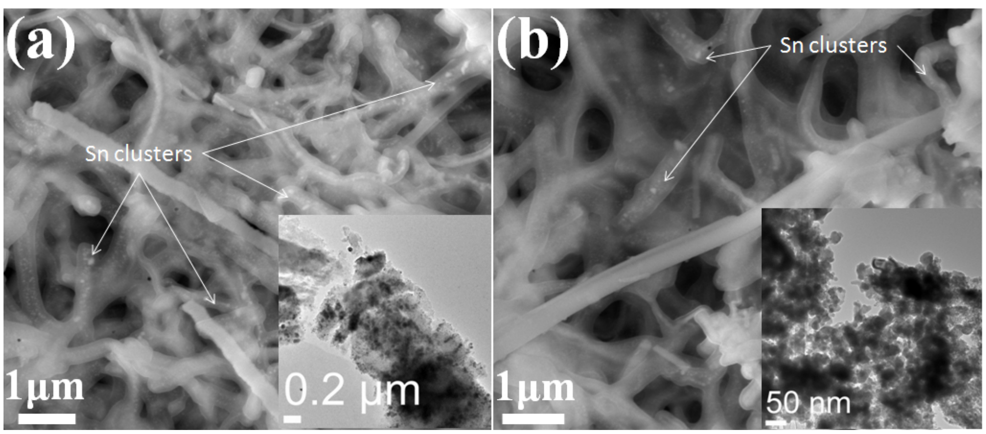

Fig. S8: SEM, TEM (inset) images of thin layer of titania-(a), alumina-(b) coated SnO_2 NWs after cycling. The white spot as Sn clusters are presence in either titania- or alumina-coated SnO_2 NWs

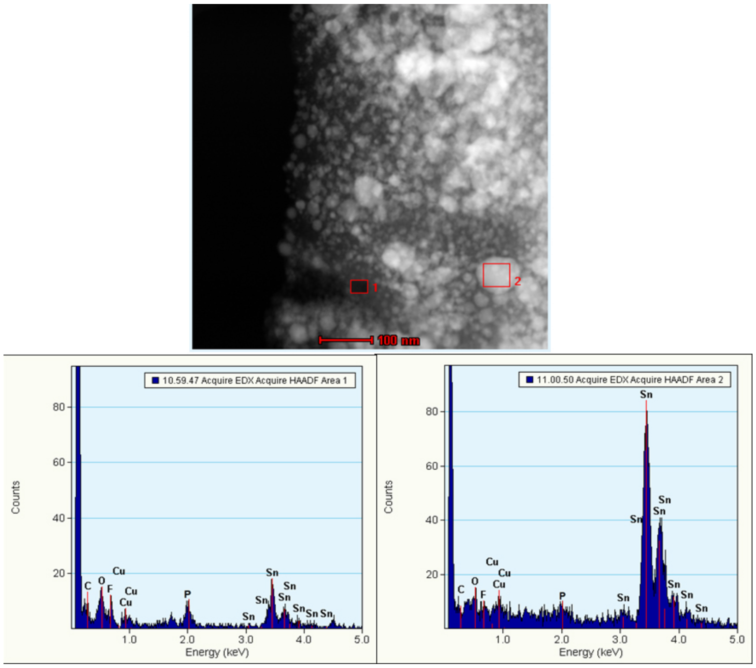

Fig. S9: EDS data of 5 nm titania-coated SnO_2 NWs after cycling

Table S2: Young's and bulk modulus of alumina and titania

	E, GPa	G, GPa	Structure	Ref.
	36-43		10-18 nm wall thickness, 35-70 nm diameter, nanotube	[1]
	23		10 nm wall thickness, 65 nm diameter, nanotube	[2]
Titania	**44**		30 nm wall thickness, 80 nm diameter, nanotube	[2]
	151		200 nm thickness, anatase film	[3]
	146		280 nm thickness film	[4]
		140		[5]
Alumina	**168-182**		50-300 nm thickness film	[6]
		235		[7]

Titania nanotube deformation calculations

For a thin wall titania tube with external and internal nominal diameters of ~75 nm and ~65 nm, **Shokuhfar** et al. has reported that the maximum axial strain of 5%. Assuming that the radial strain is the same as axial strain (it should be actually smaller), we can calculate the volume expansion of a titania shell of 10 nm wall thickness, 300 nm inner diameter as following:

$$\%Volume = \frac{V_2}{V_1} = \frac{\pi R_2^2 L_2}{\pi R_1^2 L_1} = \frac{\pi \left(R_1 + 0.05R_1\right)^2 \left(L_1 + 0.05L_1\right)}{\pi R_1^2 L_1}$$

$$= 115.7\%$$

where V_1, V_2 are volume of titania nanotube before and after deformation, respectively

R_1, R_2 are inner radius of titania nanotube before and after deformation, respectively

L_1, L_2 are length of titania nanotube before and after deformation, respectively.

References

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