Solid state interdigitated Sb_2S_3 based TiO_2 nanotube solar cells

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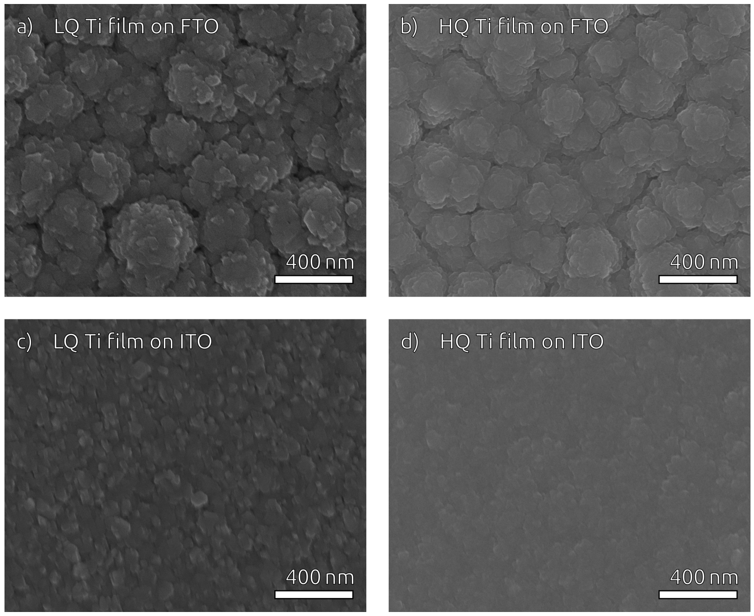

Figure S1. Ti films grown under different conditions on FTO and ITO with a working pressure and power density of 0.3 Pa and 3.3 W cm^{-2} (HQ Ti on ITO) and 0.5 Pa and 2.7 W cm^{-2} (LQ Ti on ITO). a) LQ Ti film grown on FTO, b) HQ Ti film grown on FTO, c) LQ Ti film grown on ITO, d) HQ Ti film grown on ITO.

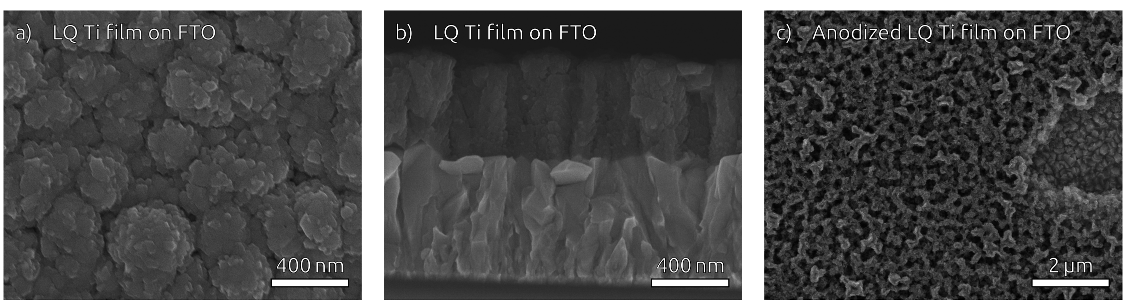

Figure S2. a,b) SEM top view (a) and cross section (b) of LQ Ti films on FTO. c) SEM top view of the anodized LQ Ti film.

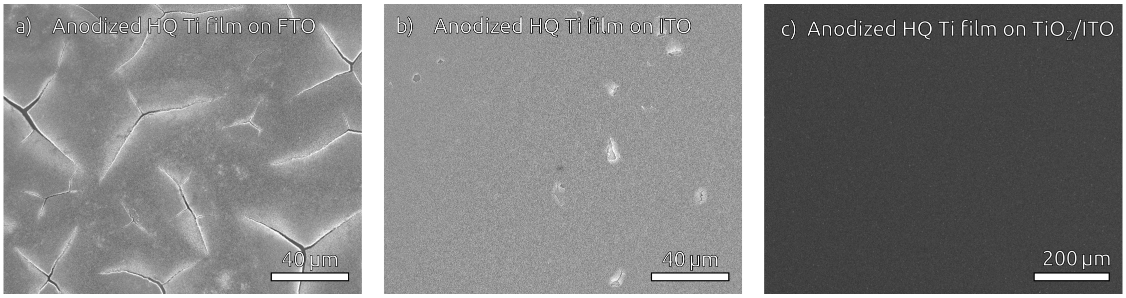

Figure S3. As-anodized HQ Ti films directly grown on FTO (a) and ITO (b) substrates without amorphous TiO_2 blocking layer. c) As-anodized HQ Ti films grown on TiO_2/ITO.

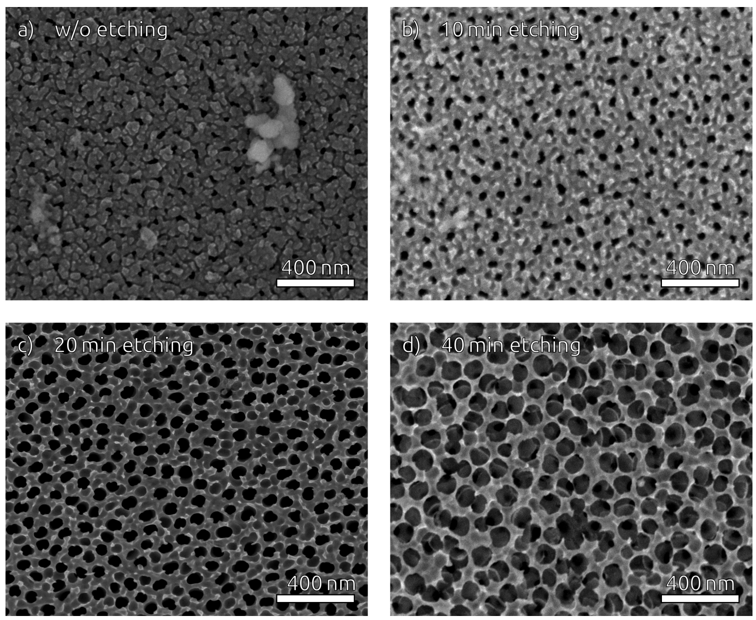

Figure S4. Influence of etching duration on TiO_2 NT morphology. a) without etching, b) 10 min of etching, c) 20 min of etching, d) 40 min of etching.

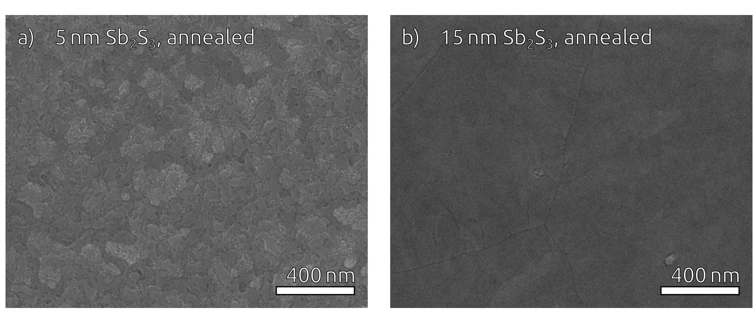

Figure S5. Dewetting effect of 5 nm (a) and 15 nm Sb_2S_3 on planar TiO_2/ITO substrates.

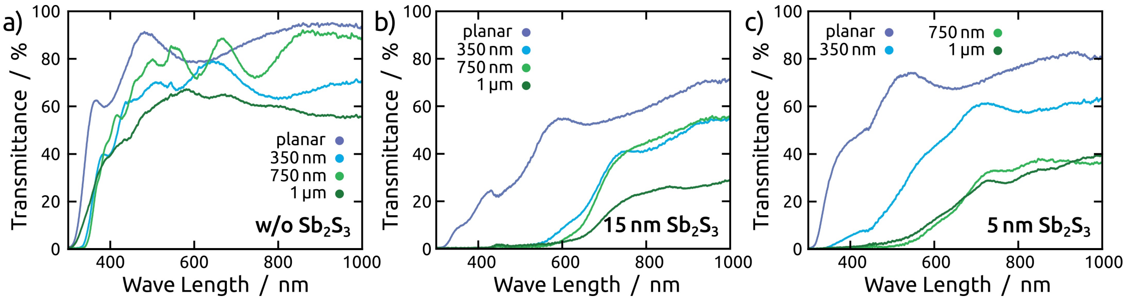

Figure S6. Direct transmission measurements of planar and TiO_2 NT substrates on TiO_2/ITO before (a) and after deposition and crystallization of 15 nm Sb_2S_3 (b) or 5 nm Sb_2S_3.

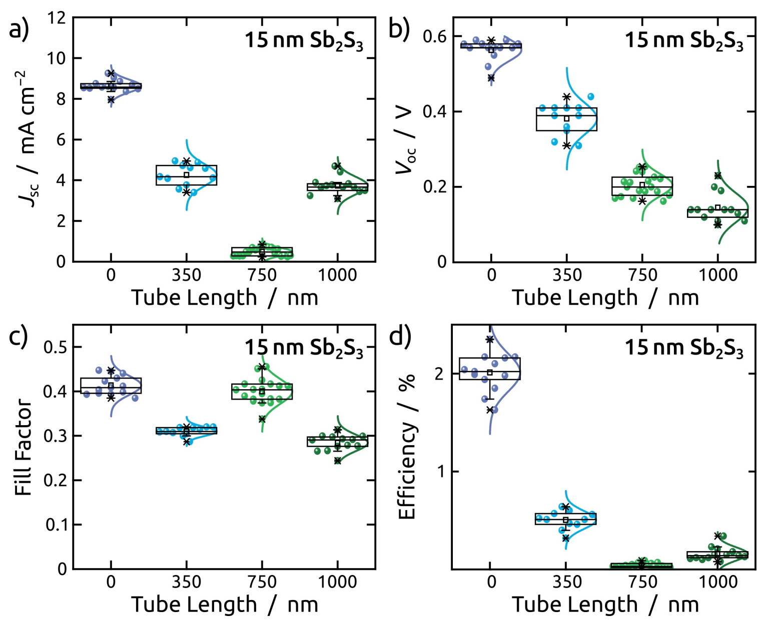

Figure S7. Device statistics for 15 nm of Sb_2S_3 on TiO_2 NT substrates with different NT lengths. a) Short circuit current density, b) open circuit potential, c) fill factor, d) efficiency.

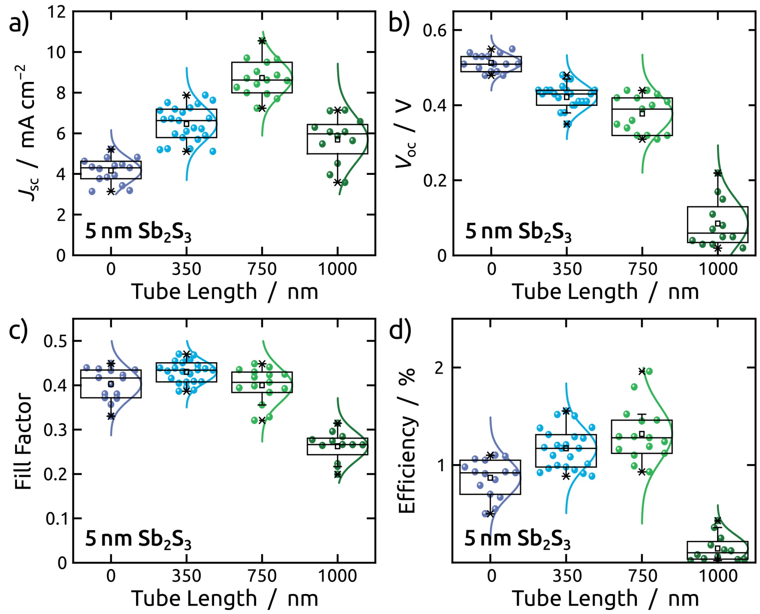

Figure S8. Device statistics for 5 nm of Sb_2S_3 on TiO_2 NT substrates with different NT lengths. a) Short circuit current density, b) open circuit potential, c) fill factor, d) efficiency.

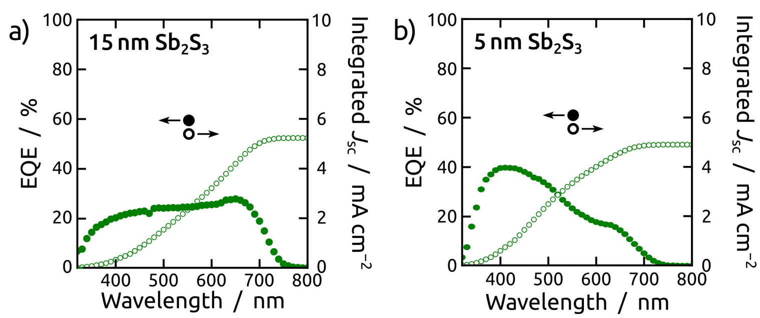

Figure S9. EQE with integrated photocurrent dentsity for TiO_2 NT length of 1 μm with an Sb_2S_3 thickness of a) 15 nm and b) 5 nm.

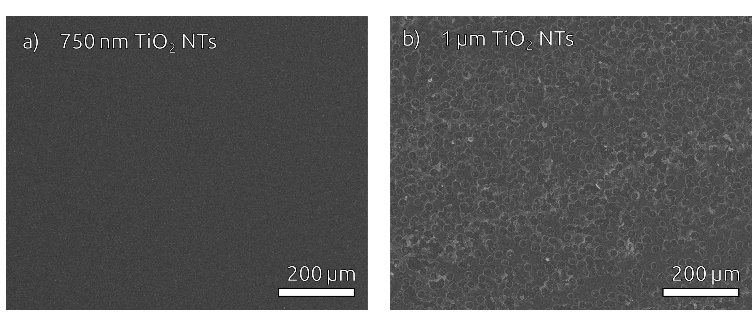

Figure S10. Low magnification SEM images of TiO_2 NT layers for NT lengths of a) 750 nm and b) 1 μm, showing the formation of cracks as the adhesion of the NT layer fails to accommodate the evolving strain due to volume expansion during anodization.

Table S1. Literature summary of Sb_2S_3 solar cells based on well-defined nanostructures and the current record efficiencies for both planar thin film and mesoporous sensitized configuration.

Cell type	Nanostructure	Efficiency [%]	Year	Ref.
Sensitized	mesoporous TiO_2	7.5	2014	1
Thin film	planar	6.56	2019	2
Thin film	TiO_2 NRs	5.8	2019	3
Thin film	TiO_2 NRs	6.78	2018	4
Coaxial	Si NRs	0.25	2015	5
Coaxial	ZnO NRs	0.2	2019	6
Coaxial	ZnO / ZnS NRs	1.32	2014	7
Coaxial	TiO_2 NRs	0.4	2019	6
Coaxial	TiO_2 NRs	0.67	2016	8
Coaxial	TiO_2 NRs	1.47	2013	9
Coaxial	TiO_2 NRs	3.76	2019	10
Coaxial	TiO_2 NRs	5.37	2020	11
Coaxial	TiO_2 dendrides	1.53	2018	12
Coaxial	TiO_2 dendrides	1.56	2018	13
Coaxial	TiO_2 dendrides	1.83	2019	14
Coaxial	TiO_2 NTs	*not specified*	2015	15
Coaxial	TiO_2 NTs	0.95	2016	16
Coaxial	TiO_2 NTs	2.1	2020	***This work***

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