Supporting information

In-plane anisotropic faceting of single-crystalline colloidal SnS nanosheets

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Experimental Section

Preparation of 2D SnS Nanosheets: In a typical reaction, a mixture of $Sn(CH_3CO_2)_2$ (TA, 0.25 mmol), oleic acid (OA, 0.64 mmol) and octadecene (ODE, 10 mL) is added into the reaction flask, where ODE serves as solvent and OA acts as capping ligand. After continuous heating to 180 ^oC for about 15 min, the mixture is completely dissolved. Then, the reaction solution is cooled down to 75 ^oC, degassed and dried under vacuum for 2h. Then, the solution is heated up to 300 ^oC and trioctylphosphine-S (TOP-S, 1M) is quickly injected into the flask. After 5 min reaction, the solution is cooled down to room temperature. The products are purified by centrifugation with toluene at 2000 rpm for 3 min (2-3 times) and then dispersed again in toluene with good dispersity for further characterization or storage.

Material Characterization: Transmission electron microscope (TEM) images and selected area electron diffraction (SAED) were performed with a JEOL-1011 transmission electron microscope (Jeol, Tokyo, Japan, at 100 kV). The high resolution (HR) TEM images were obtained by using a Philips CM 300 UT microscope (200 kV). XRD measurements were conducted by operating a Philips X'Pert System with Bragg-Brentano geometry (a copper anode at an X-ray wavelength of 0.154 nm). The height measurements were performed by using an atomic force microscope (AFM, JPK). SEM images were obtained from a LEO GEMINI 1550 microscope.

Device preparation: SnS nanosheets suspended in toluene were spin-coated on silicon wafers with 300 nm thermal silicon oxide. The individual nanosheets were contacted by e-beam lithography followed by thermal evaporation of Ti/Au (1/55 nm) and lift-off.

Transport measurements: Immediately after device fabrication, we transferred the samples to a probe station (Lakeshore-Desert) connected to a semiconductor parameter analyzer (Agilent B1500a). All the measurements have been performed in vacuum at room temperature.

Figures and Tables

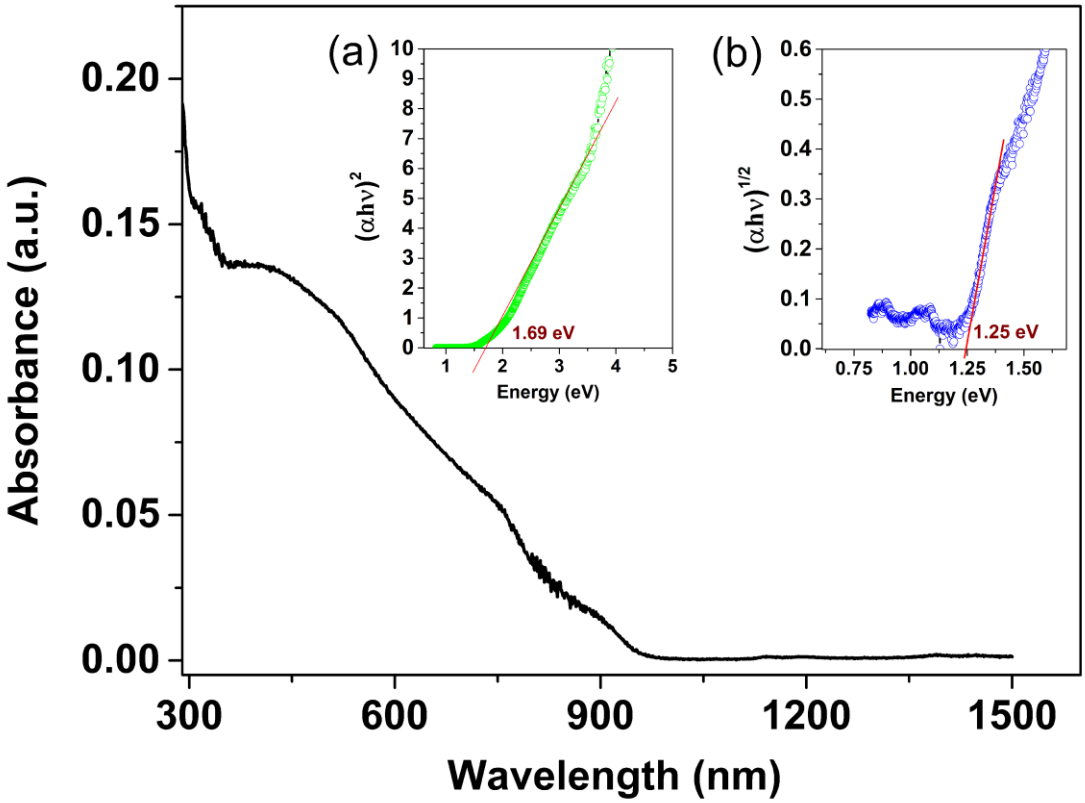

Figure S1. Optical absorbance spectra of a-SnS NSs (inset a is $(\alpha h\upsilon)^2$ versus photon energy hυ plot for direct band gap and inset b is $(\alpha h\upsilon)^{1/2}$ versus photon energy hυ plot for indirect band gap of SnS NSs.

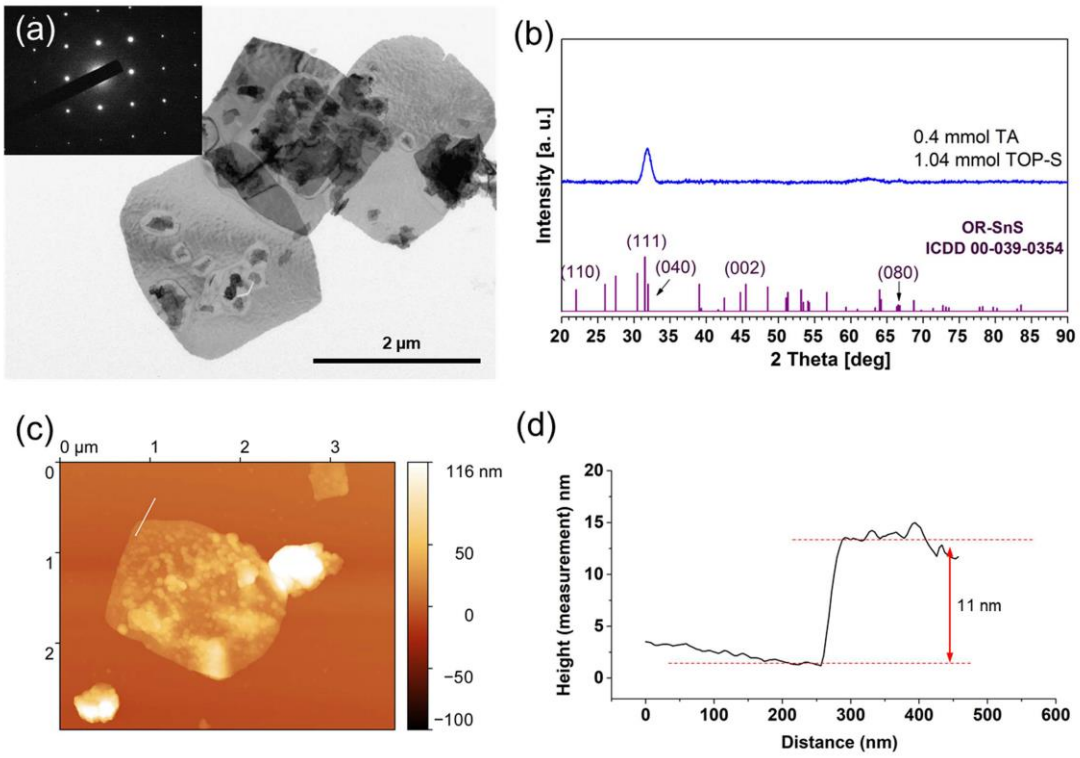

Figure S2. The characterization of the thinnest SnS NSs. (a) TEM image and SEAD pattern (inset). (b) XRD patterns for SnS NSs drop-casted on a Si wafer (thin film). (c) AFM image and height image (d) of the single SnS nanosheet.

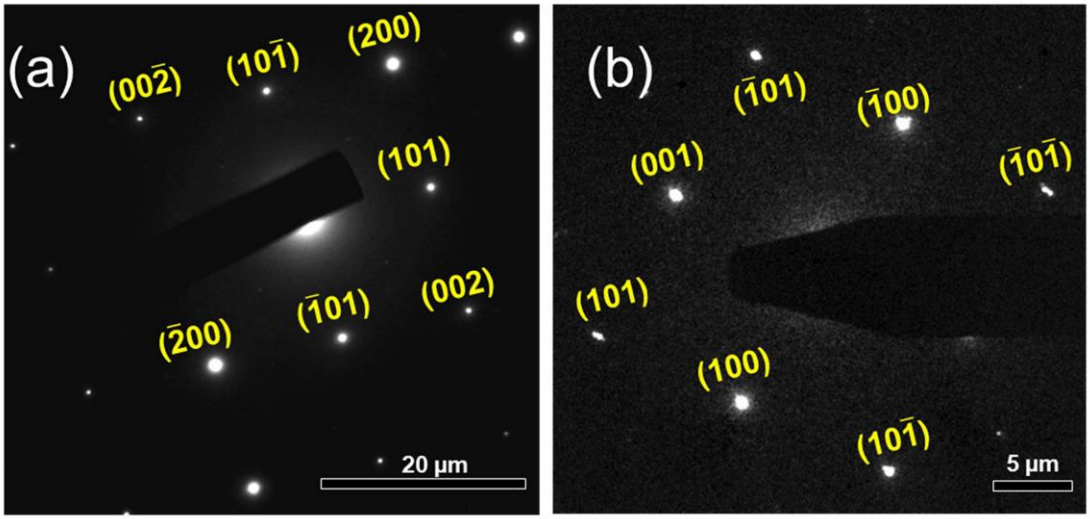

Figure S3. The corresponding SAED patterns of i-SnS (a) and a-SnS (b) NSs from Figure 2e.

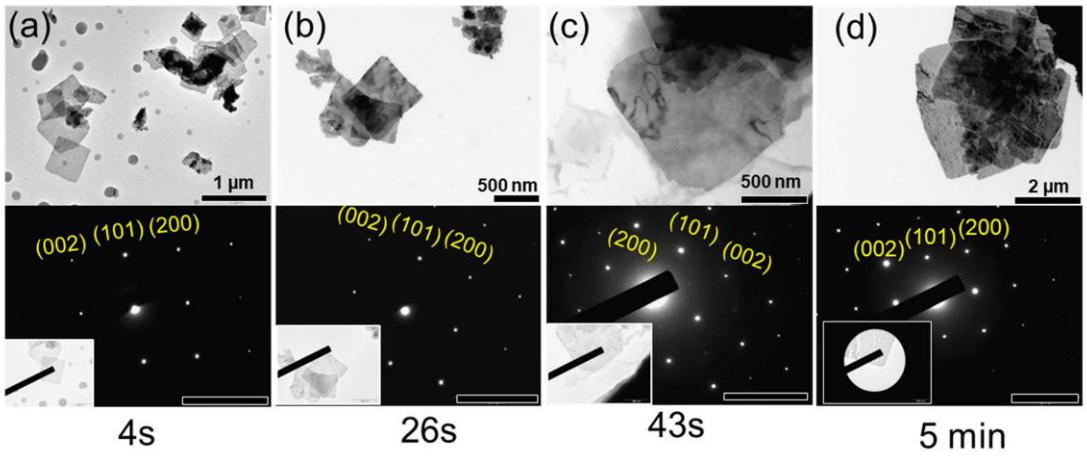

Figure S4. TEM images of solution aliquots were taken at 4 s (a), 26 s (b), 43s (c), 5 min (d) during reaction. Scale bar=20 μm for all SAED patterns in a-d.

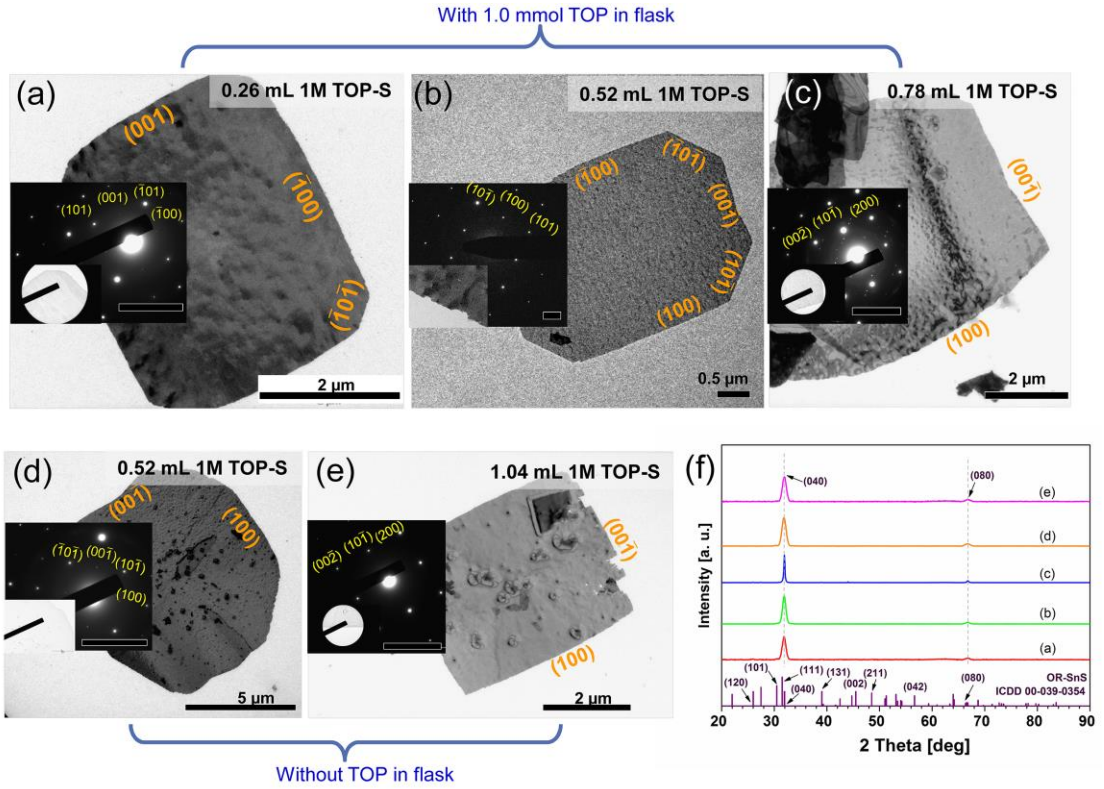

Figure S5. TOP-S amount variation for a-SnS NSs with 1.0 mmol TOP in flask (a-c) and without TOP in flask (d, e). Scale bar=20 μm, 5 μm, 20 μm, 20 μm, 20 μm for SAED patterns from the insets of a-e.

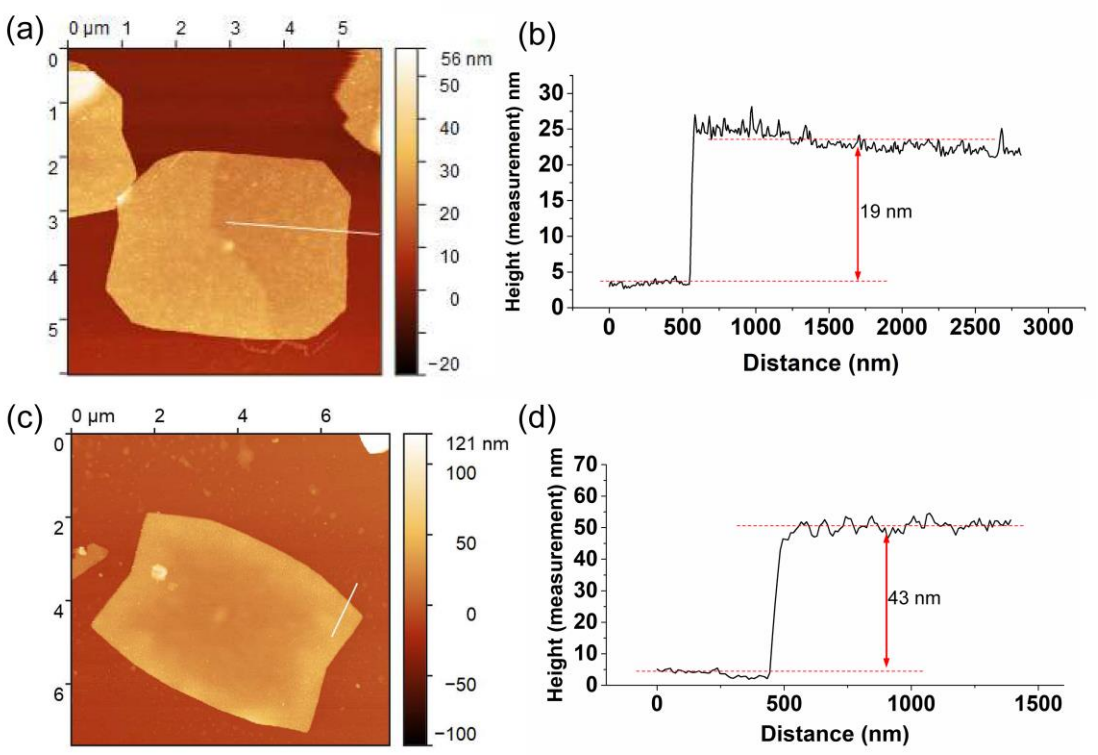

Figure S6. AFM image and measured height image of synthesized SnS nanosheets with 1.0 mmol TOP (in flask) and 1M TOP-S with the volume of 0.52 mL (a,b) and 0.78 mL (c, d) for the hot-injection in the reaction.

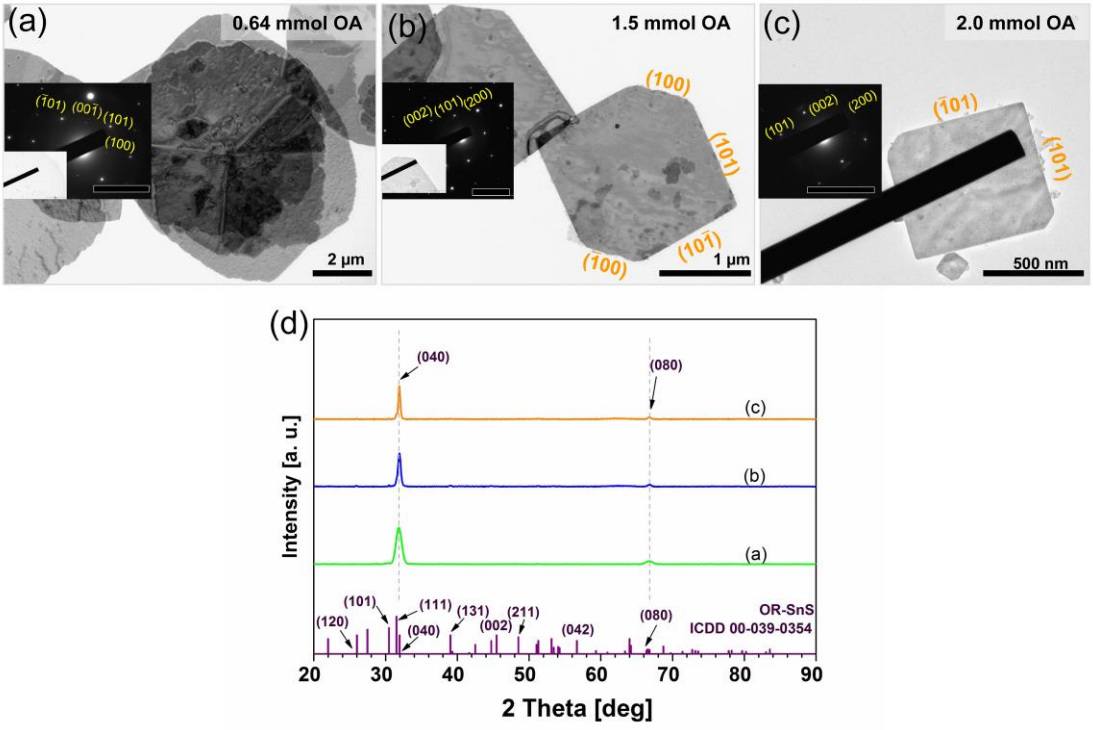

Figure S7. TEM analysis (a-c) and XRD patterns (d) of the syntheses of i-SnS NSs via oleic acid amount variation without TOP in flask before injection of TOP-S.

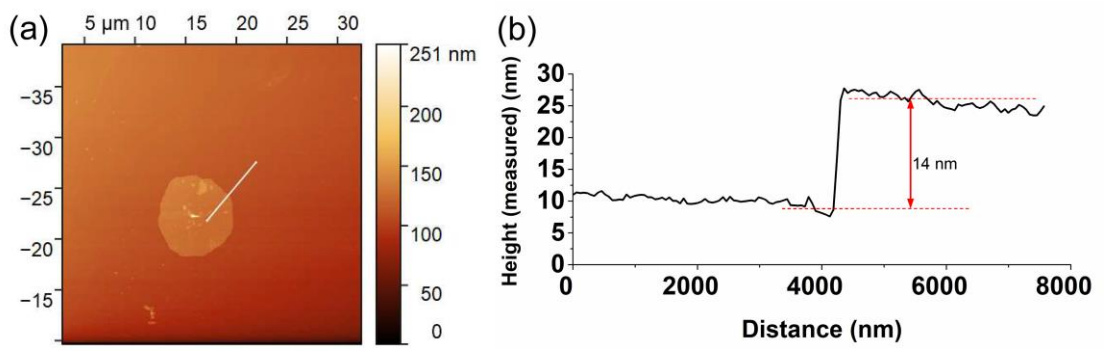

Figure S8. AFM image and measured height image of synthesized round SnS nanosheets with 0.64 mmol OA and no TOP (from the flask) in reaction.

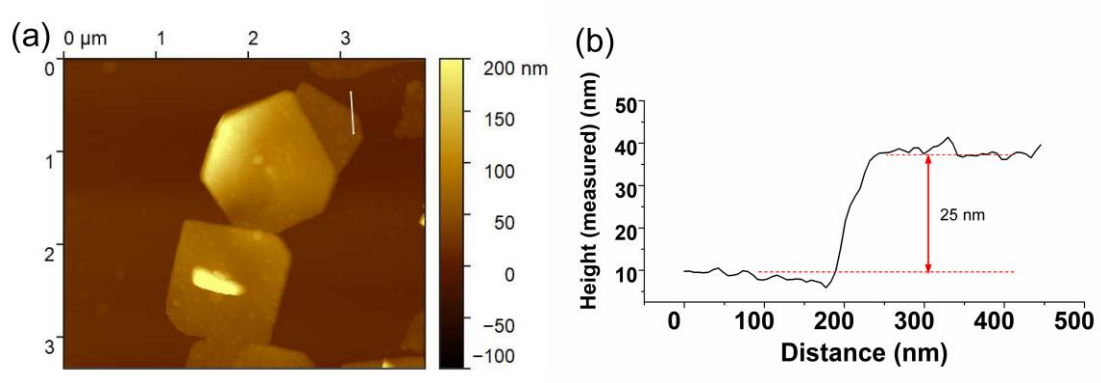

Figure S9. AFM image and measured height image of synthesized square SnS nanosheets with 1.5 mmol OA and no TOP (in flask) in reaction.

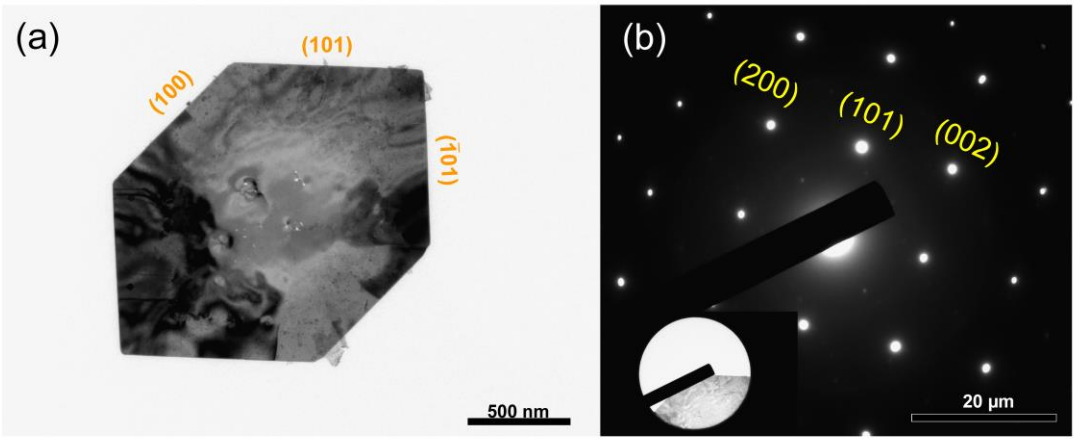

Figure S10. High amount of Oleic acid (1.5 mmol) for the synthesis of i-SnS NSs with 1.0 mmol TOP in flask before injection of TOP-S. Scale bar=500 nm, 20 μm for TEM image and SAED pattern.

Table S1: Adsorption energy [eV] of ligand molecules on the (100), (101), (001) and (010) facets of SnS calculated by the density functional theory (DFT) method. The simulations of simplified TOP with different chain lengths (C2 and C4) show that the tendencies are similar compared to the results of a C3 chain length in Table 1.

	SnS-101 side facet (isotropic)	**SnS-100 side facet (anisotropic-zigzag)**	**SnS-001 side facet (anisotropic-armchair)**	**SnS-010 top facet (Top or down)**
TEP-S (C2)	1.660	2.183	1.657	1.118
TBP-S (C4)	1.972	2.761	2.067	1.364