Supporting Information:

A Strategy for Low Thermal Conductivity and Enhanced Thermoelectric Performance in SnSe: Porous $SnSe_{1-x}S_x$ Nanosheets

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Supporting Information Contents:

1. Figures

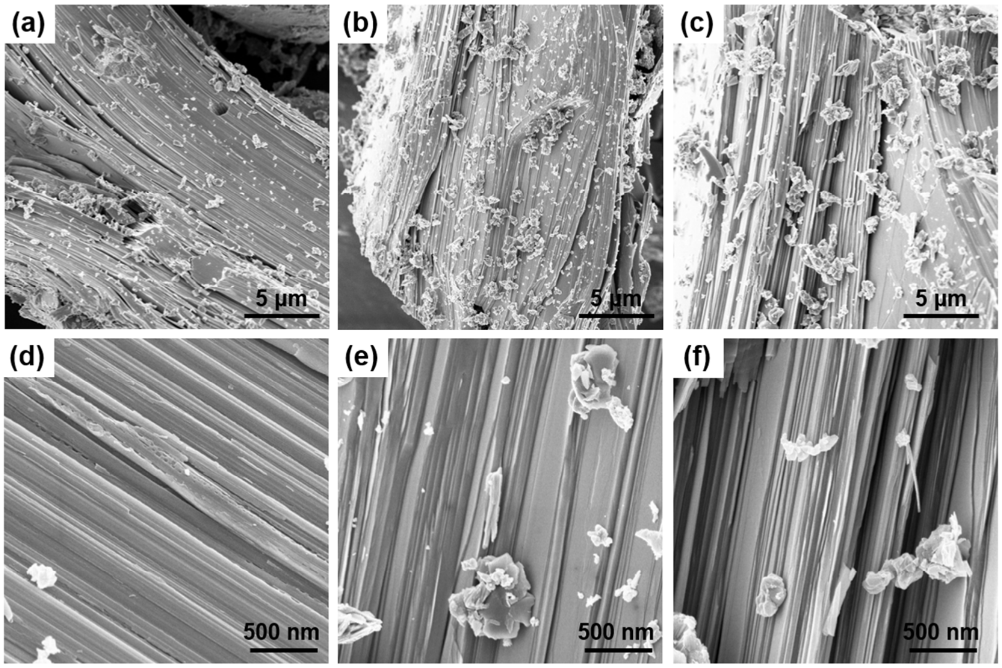

Figure S1. Low- and high-magnification FE-SEM images of the $SnSe_{1-x}S_x$ powders. (a,d) $SnSe_{0.6}S_{0.4}$, (b,e) $SnSe_{0.4}S_{0.6}$, (c,f) $SnSe_{0.2}S_{0.8}$.

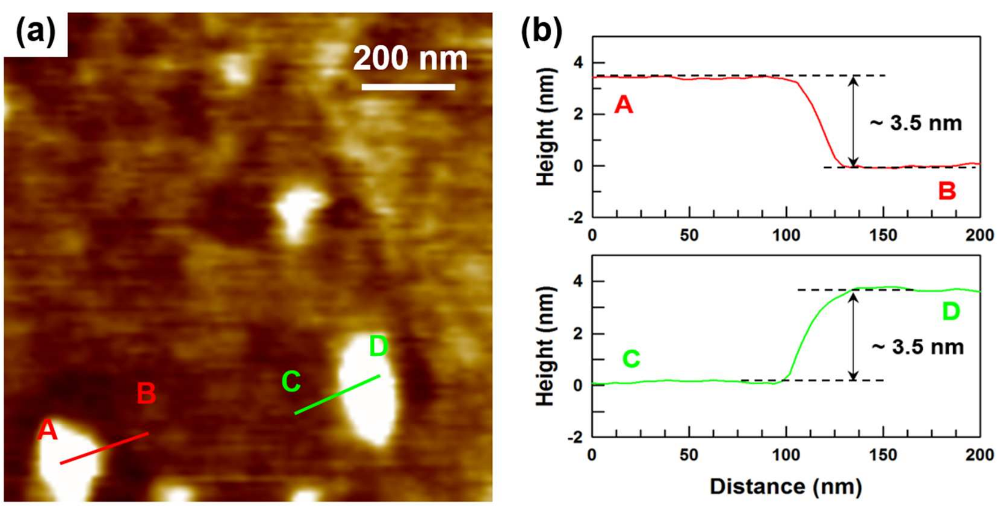

Figure S2. (a) AFM image and (b) the corresponding height profile of the exfoliated $SnSe_{0.8}S_{0.2}$ NS.

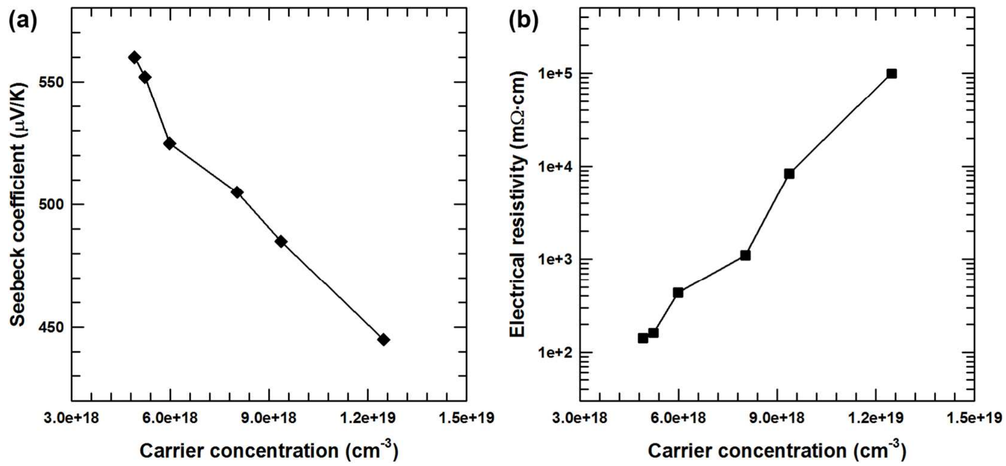

Figure S3. (a) Seebeck coefficient and electrical resistivity values of $SnSe_{1-x}S_x$ NSs as a function of the carrier concentration.

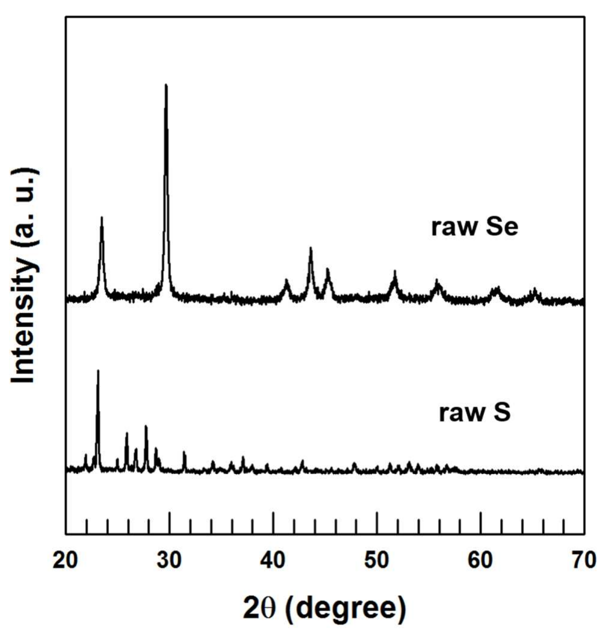

Figure S4. XRD patterns of the pristine Se and S materials.

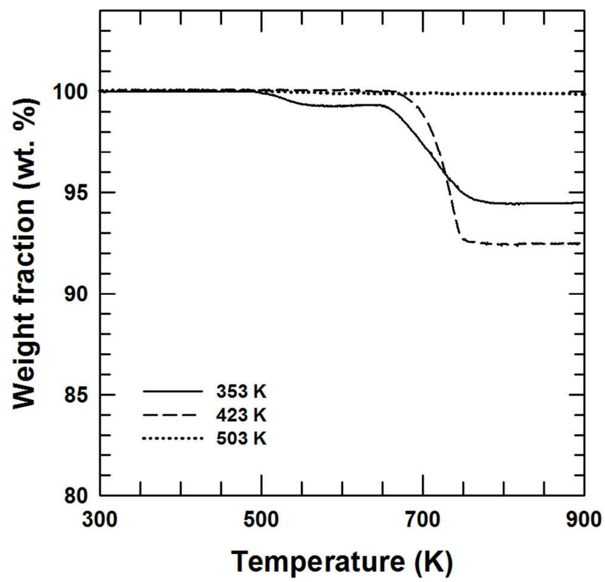

Figure S5. TGA results of the porous $SnSe_{0.8}S_{0.2}$ NSs at the reaction temperature of 353, 423, and 503 K.

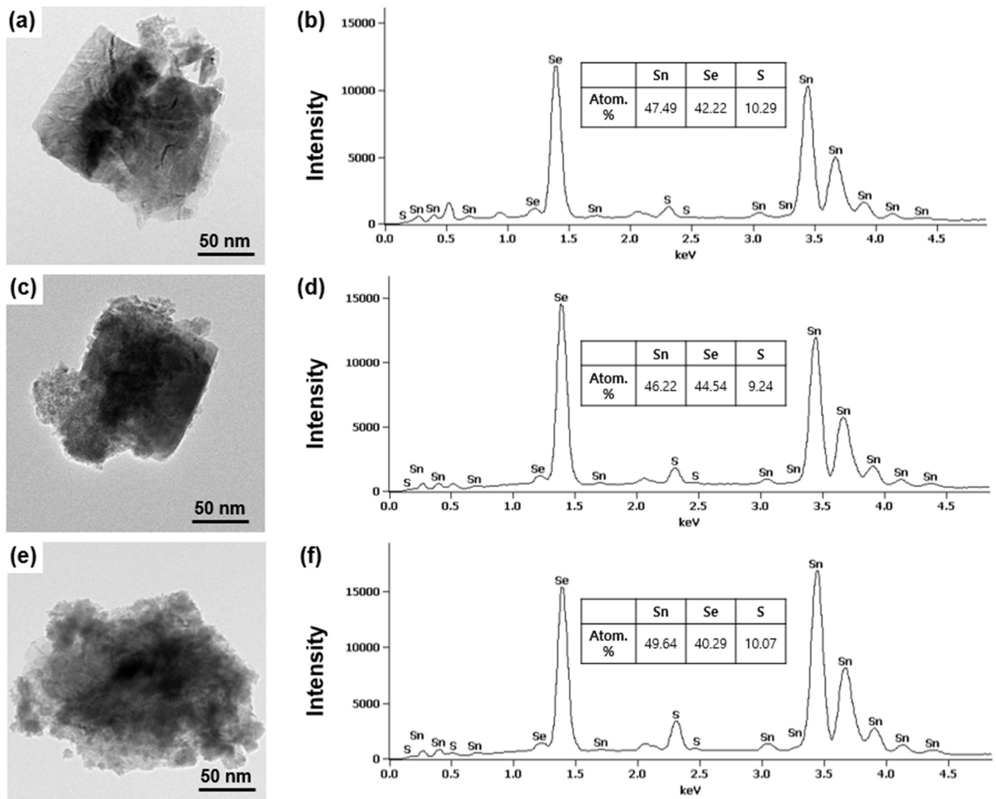

Figure S6. FE-TEM images and the corresponding EDS results for porous $SnSe_{0.8}S_{0.2}$ NSs at the reaction temperature of (a–b) 353, (c–d) 423, and (e–f) 503 K.

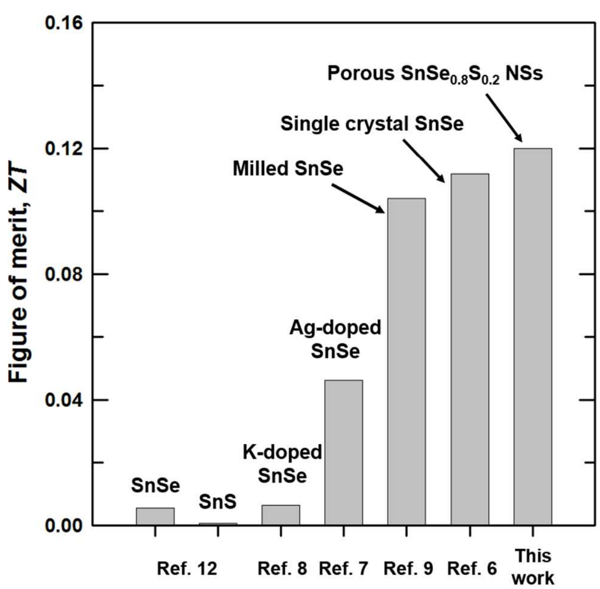

Figure S7. *ZT* value of the porous $SnSe_{0.8}S_{0.2}$ NSs in this work compared with previously reported results regarding SnSe-based materials at 300 K.

2. Tables

Material	Thermal conductivity (W/m·K)	Note
Bi_2Te_3	1.09	Previously reported work
Nanostructured BiSbTe	1.12	
Nanostructured PbTe	1.45	
Nanostructured PbSe	1.3	
PbS	2.7	

Nanoscale holey Si	2.03	
Nanostructured SiGe	2.5	
$CoSb_3$	10	
$AgSn_4SbTe_6$ (LAST)	1.8	
Bulk SnSe	1	
$SnSe_{0.8}S_{0.2}$ NSs	0.55	This work
Porous $SnSe_{0.8}S_{0.2}$ NSs	0.4	

Table S1. Thermal conductivity values of the $SnSe_{0.8}S_{0.2}$ NSs and porous $SnSe_{0.8}S_{0.2}$ NSs compared with previously reported thermal conductivities for various thermoelectric materials at 300 K.

	Before reaction	353 K	423 K	503 K
Sn	50	47.49	46.22	49.64
Se	40	42.22	44.54	40.29
S	10	10.29	9.24	10.07

Table S2. Atomic ratios corresponding to the EDS spectra with different reaction temperatures.

3. Extended discussion

Extended Discussion S1. Detailed description for the parallel-connected model for the $SnSe_{1-x}S_x$ crystals.

The parallel-connected model in the $SnSe_{1-x}S_x$ can be written as:

$$\sigma_{SnSeS} = (1 - x_S)\sigma_{Se} + x_S\sigma_S \quad (1)$$

where σ_{SnSeS}, x_S, σ_S, and σ_{Se} are the parallel-connected electrical conductivity of the $SnSe_{1-x}S_x$, volume fraction of the SnS, electrical conductivity of the SnS, and electrical conductivity of the SnSe, respectively. The Seebeck coefficient with different SnS concentrations can be fitted with a parallel-connected two-component model, which is described as:

$$S_{SnSeS} = \frac{(1-x_S)\sigma_{Se}S_{Se}+x_S\sigma_S S_S}{(1-x_S)\sigma_{Se}+x_S\sigma_S} \quad (2)$$

where S_{SnSeS}, S_{Se}, and S_S, are the parallel-connected Seebeck coefficient of the $SnSe_{1-x}S_x$, and the Seebeck coefficients of the SnSe and SnS, respectively.