Electronic Supplementary Information

Thermoelectric performance of SnS and SnS-SnSe solid solution

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1. The heat capacity of $SnS_{1-x}Se_x$ solid solution.

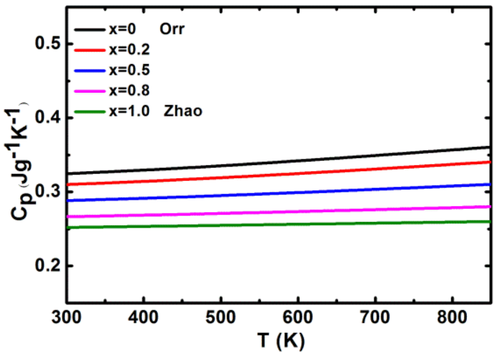

Figure S1. The heat capacity (C_P) $SnS_{1-x}Se_x$ (x=0, 0.2, 0.5, 0.8, 1.0) solid solution. The C_p of SnS and SnSe are obtained from Orr an Zhao's works.[1, 2] The C_P of $SnS_{1-x}Se_x$ (x=0.2, 0.5, 0.8) was calculated by linear fitting from C_p of SnS and SnSe.

2. The orientation factor calculation

The orientation factor calculation can be expressed as:

$$F = \frac{1-P}{1-P_0}, \tag{1}$$

where P and P_0 can be calculated from the experiment data and the refinement documents.[3] The P and P_0 can be expressed as below:

$$P = \frac{\sum I(h00)}{\sum I(hkl)}, \tag{2}$$

and $$P_0 = \frac{\sum I_0(h00)}{\sum I_0(hkl)}. \tag{3}$$

Here I(h00) is the peak intensity of (h00) planes and I(hkl) is the peak intensity of all peaks. I_0(h00) is the peak intensity of (h00) and I_0(hkl) is the peak intensity of (hkl) according to cell refinement data. In cell refinement data, all the peaks was seen to emerge for equal possibility.

Table S1. The orientation factors of $SnS_{1-x}Se_x$ solid solution. The data of SnSe got from ref. 4.

Sample	Orientation Factor		
	Powder	∥ pressuring direction	⊥ pressuring direction
SnS	0.66	0	0.22
$SnS_{0.2}Se_{0.8}$	0.72	0	0.26
$SnS_{0.5}Se_{0.5}$	0.72	0	0.30
$SnS_{0.8}Se_{0.2}$	0.68	0	0.20
SnSe[4]	0.69	0	0.32

3. Thermoelectric performances $SnS_{0.2}Se_{0.8}$

The thermoelectric properties of $SnS_{0.2}Se_{0.8}$ along two directions were shown in Fig. 3. Compared to ⊥ direction, the electrical resistivity (ρ) and Seebeck coefficient (S) are higher and the thermal conductivity (κ) is lower along ∥ direction. The difference in ρ, S and κ comes from the preferred orientation of (400) plane and it has the lowest carrier mobility (μ) and lattice thermal conductivity (κ_L).[2] Unlike the great difference of electrical resistivity and thermal conductivity along two directions, the difference of Seebeck coefficient along two directions was small and the Seebeck coefficient along parallel to pressing direction is little higher than the Seebeck coefficient along perpendicular to pressing direction. Although the electrical properties along ∥ direction are lower than ⊥ direction, the lower κ along ∥ direction than ⊥ direction is beneficial to the thermoelectric performance along ∥ direction, and higher zT of 0.82 was reached along ∥ direction than zT of 0.62 along ⊥ direction. Therefore, the thermoelectric performance along ∥ direction is higher than along ⊥ direction.

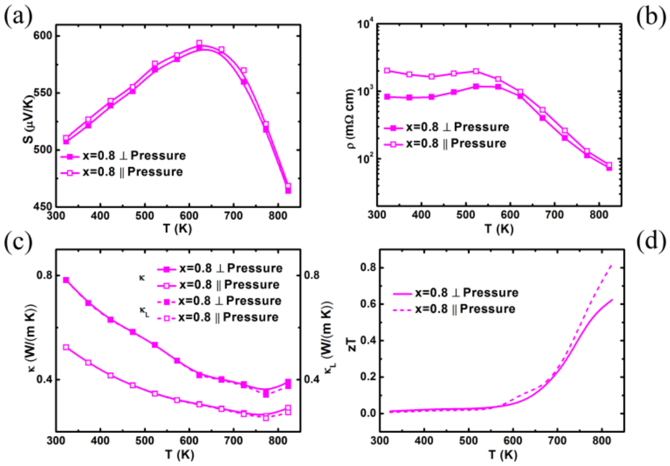

Figure S2. Thermoelectric performance of $SnS_{0.2}Se_{0.8}$ at different temperature along different directions. (a) the Seebeck coefficient, (b) the electrical resistivity, (c) the thermal conductivity and lattice thermal conductivity and (d) the zT values.

Reference:

1. R. Orr and A. Christensen, *J. Phys. Chem.*, 1958, **62**, 124.
2. L. Zhao, S. Lo, Y. Zhang, H. Sun, G. Tan, C. Uher, C. Wolverton, V. Dravid and M. Kanatzidis, *Nature*, 2014, **508**, 373.
3. F. Lotgering, *J. Inorg. Nucl. Chem.*, 1959, **9**, 113.
4. J. Zhao, M. Zhou, Y. Han, H. Leng, L. Li, *Solid State Commun.*, 2014, Submitted.