Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information:

Solution-processable flexible thermoelectric composite films based on conductive polymer/$SnSe_{0.8}S_{0.2}$ nanosheets/carbon nanotube for wearable electronic applications

Hyun Ju, Dabin Park, and Jooheon Kim*

School of Chemical Engineering & Materials Science,

Chung-Ang University, Seoul 06974, Republic of Korea

*Corresponding author: jooheonkim@cau.ac.kr (J. Kim)

Supporting Information Contents:

1. Figures
2. Tables
3. Extended discussions

1. Figures

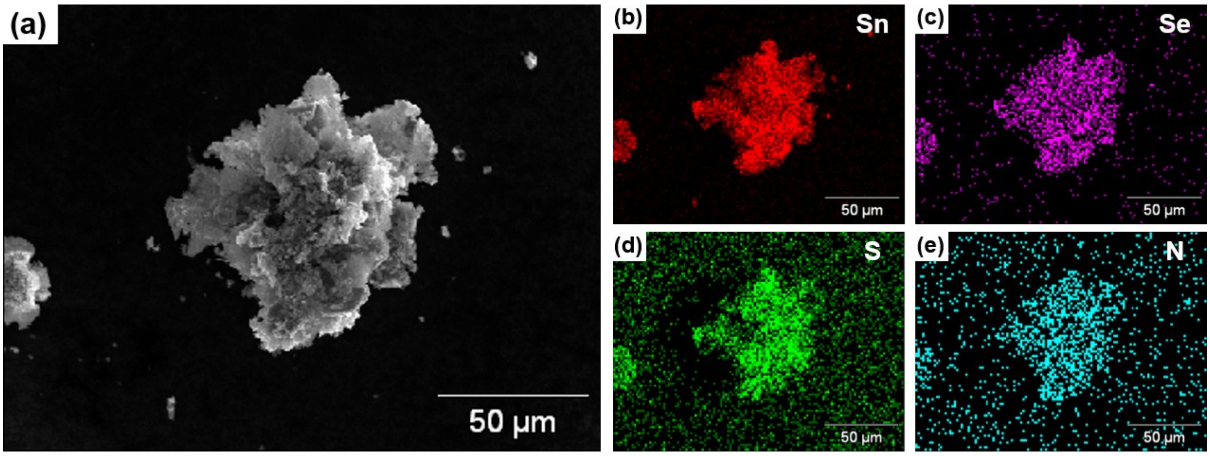

Fig. S1 FE-SEM image and the corresponding EDS mappings of CSA-PANI-coated $SnSe_{0.8}S_{0.2}$ NSs.

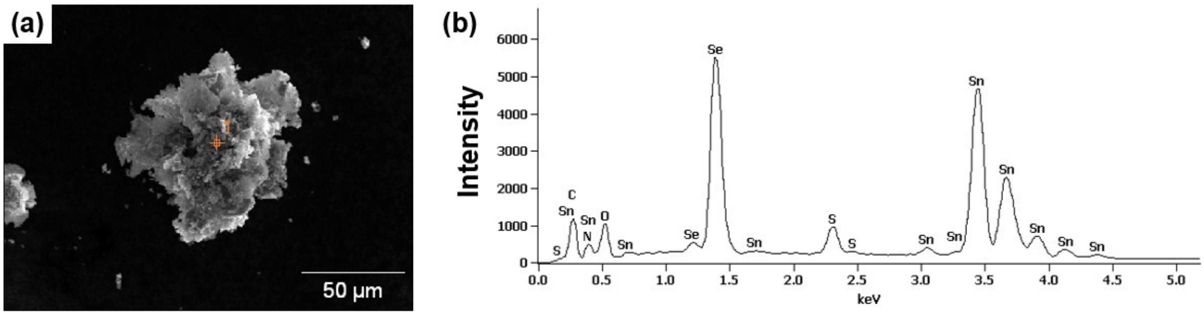

Fig. S2 FE-SEM image and the corresponding EDS spectrum of CSA-PANI-coated $SnSe_{0.8}S_{0.2}$ NSs.

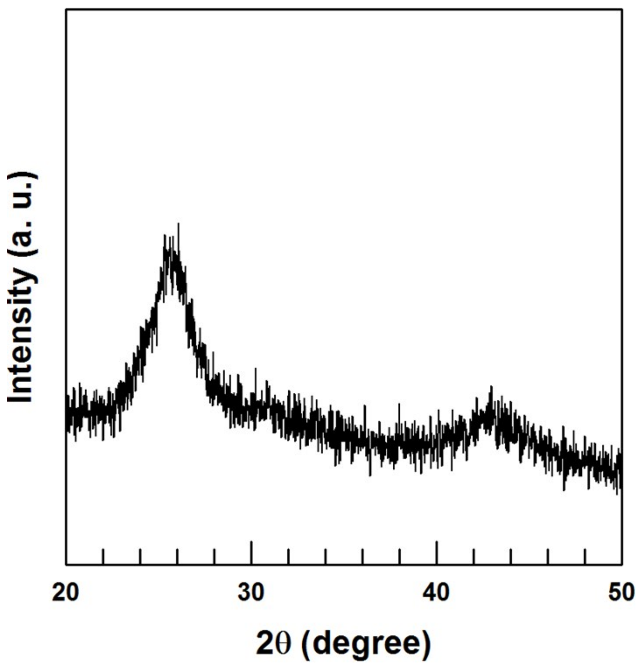

Fig. S3 XRD pattern of pristine CNT.

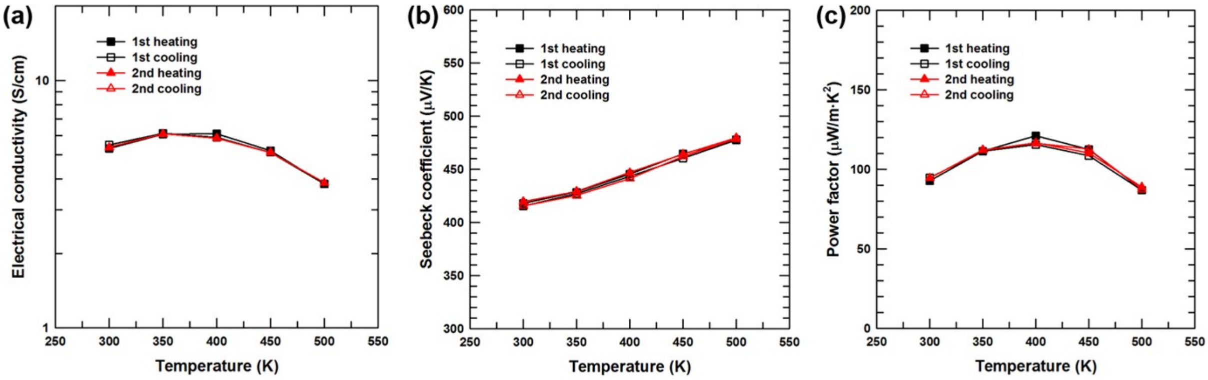

Fig. S4 Temperature-dependent (a) electrical conductivity, (b) Seebeck coefficient, and (c) power factor values of prepared CSA-PANI-coated $SnSe_{0.8}S_{0.2}$ NS/PVDF composite film during multiple heating and cooling cycles.

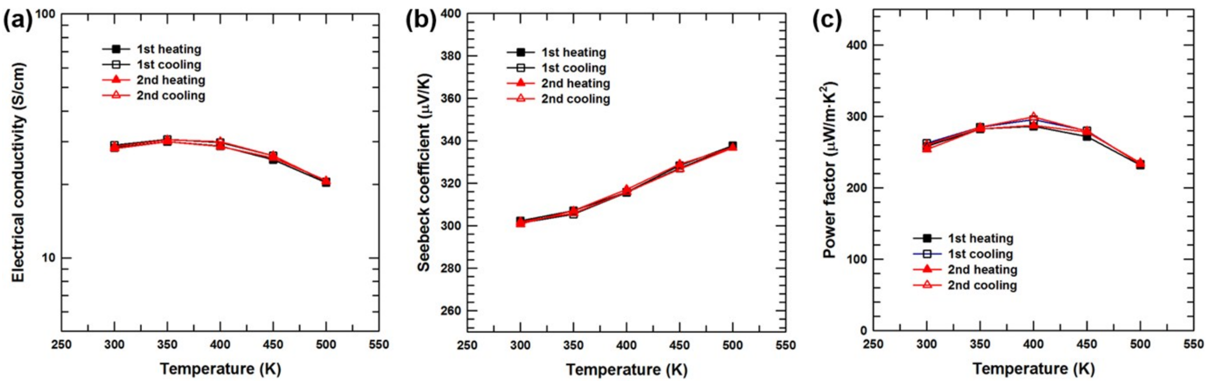

Fig. S5 Temperature-dependent (a) electrical conductivity, (b) Seebeck coefficient, and (c) power factor values of CSA-PANI-coated $SnSe_{0.8}S_{0.2}$ NS/PVDF/CNT composite film at CNT content of 0.5 wt. % during multiple heating and cooling cycles.

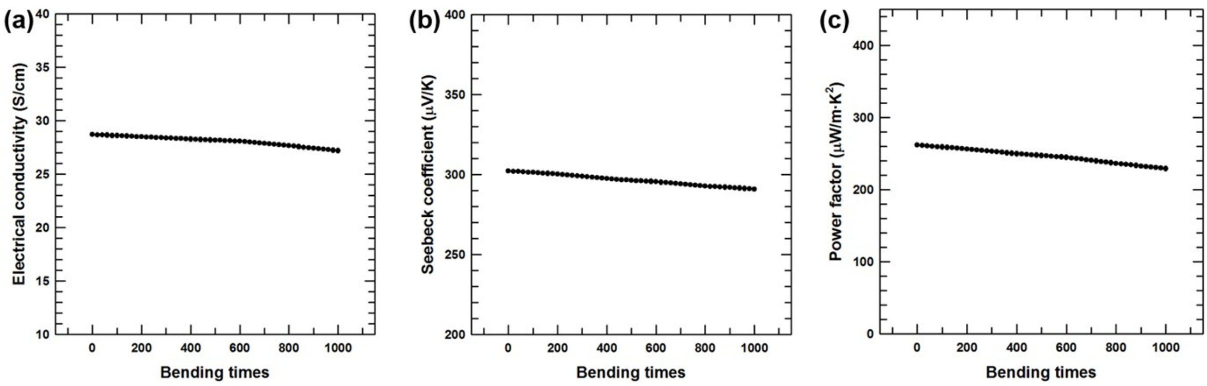

Fig. S6 (a) Electrical conductivity, (b) Seebeck coefficient, and (c) power factor values of the CSA-PANI-coated $SnSe_{0.8}S_{0.2}$ NS/PVDF/CNT composite film at CNT content of 0.5 wt. % as a function of bending cycles.

2. Tables

CNT content (wt. %)	n (cm^{-3})	μ ($cm^2/V{\cdot}s$)
0	6.73×10^{18}	5.1
0.1	6.56×10^{18}	9.8
0.2	6.46×10^{18}	17.2
0.5	6.82×10^{18}	30.8
1	6.14×10^{18}	42.3
3	7.89×10^{18}	49.5

Table S1. Carrier concentration and mobility values of CSA-PANI-coated $SnSe_{0.8}S_{0.2}$ NS/PVDF/CNT composite films with different CNT content.

Materials	σ (S/cm)	S (μV·s)	$S^2\cdot\sigma$ (μW/m·K^2)	κ (W/m·K)	ZT
Te nanorod/PVDF [6]	551.6	288	45.8	-	-
Te nanowire/PEDOT:PSS [23]	19.3	163	70.9	0.22-0.30	0.1
$Cu_{0.1}Bi_2Se_3$ nanoplate/PVDF [24]	1.46	-84	103.2	0.32	0.1
Cu_2Se nanowire/PVDF [8]	5578.2	14.16	111.84	0.79	0.04
CNT/Te nanorod/PEDOT:PSS [29]	~139	~118	~206	-	-
CSA-PANI coated SnSe0.8S0.2 NSs/PVDF (This work)	5.5	419	96.6	0.47	0.062
CSA-PANI coated SnSe0.8S0.2 NSs/PVDF/CNT (This work)	28.7	302	261.8	0.54	0.145

Table S2. Thermoelectric properties of the product fabricated in this study compared to the previously reported materials at 300 K.

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:

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

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:

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

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.