

## *Supporting Information*

### **Fabrication of high-performance flexible Ag/Ag<sub>2</sub>Se composite films for thermoelectric applications**

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#### **Note S1 Raw Materials**

Selenium powders (Se, 99.999%), sodium borohydride (NaBH<sub>4</sub>, 98%), L-Ascorbic acid (LAA, C<sub>6</sub>H<sub>8</sub>O<sub>6</sub>, 99%), and anhydrous ethanol (AR, ≥99.5%) were purchased from Shanghai Titan Technology Co., Ltd. Silver nitrate (AgNO<sub>3</sub>, 99%) was purchased from Sinopharm Chemical Reagent Co., Ltd. Nylon filter membrane with average aperture of ~ 0.22 μm was purchased from Merck Millipore Ltd.

#### **Note S2 Synthesis of Ag<sub>2</sub>Se-based nanoparticles**

Se suspension was prepared by dispersing Se powders (40 mmol) in deionized water (100 mL) under an argon atmosphere with continuous stirring for 20 min. 80 mmol NaBH<sub>4</sub> were dissolved in 50 mL of deionized water with stirring for 20 min to prepare NaBH<sub>4</sub> solution. Then the NaBH<sub>4</sub> solution was slowly added dropwise to Se suspension under an argon atmosphere. The resulting mixture was stirred at RT for 2 h, yielding an orange-red solution. 60 mmol of LAA was dissolved in deionized water (50 mL) and

slowly added dropwise to the orange-red solution, resulting in a brick-red solution (Se source).  $\text{AgNO}_3$  was dissolved in deionized water to prepare the  $\text{AgNO}_3$  source. Subsequently, a specific amount of  $\text{AgNO}_3$  source was slowly added into the Se source with stirring for 2 h at RT, and the nominal molar ratios of Ag:Se were 1.6:1, 2:1, and 2.2:1, respectively. The obtained black precipitates were centrifuged and washed alternately with deionized water and ethanol for 5 times, followed by drying in a vacuum oven at 60 °C for 24 h. The obtained nanoparticles with nominal Ag:Se molar ratios of 1.6:1, 2:1, and 2.2:1 were denoted as  $\text{Ag}_{1.6}\text{Se}$ ,  $\text{Ag}_2\text{Se}$ , and  $\text{Ag}_{2.2}\text{Se}$ , respectively.

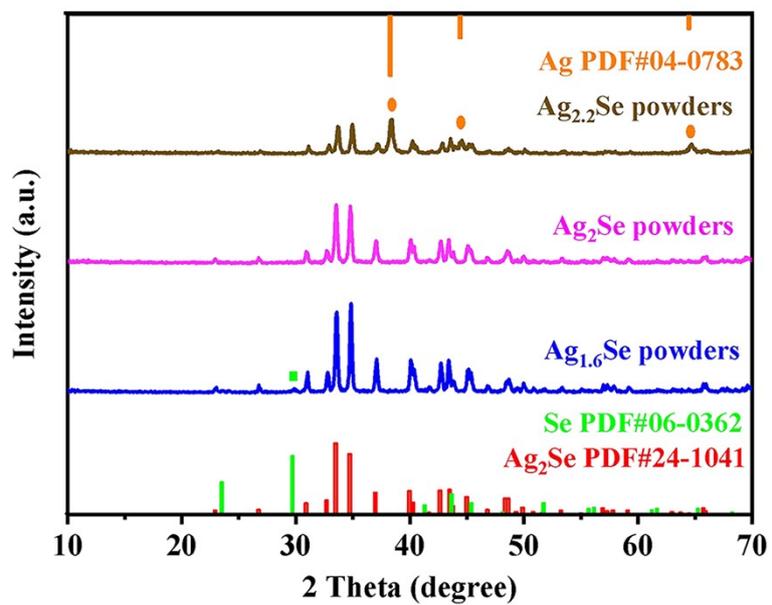


Figure S1 XRD patterns of  $\text{Ag}_{1.6}\text{Se}$ ,  $\text{Ag}_2\text{Se}$  and  $\text{Ag}_{2.2}\text{Se}$  powders

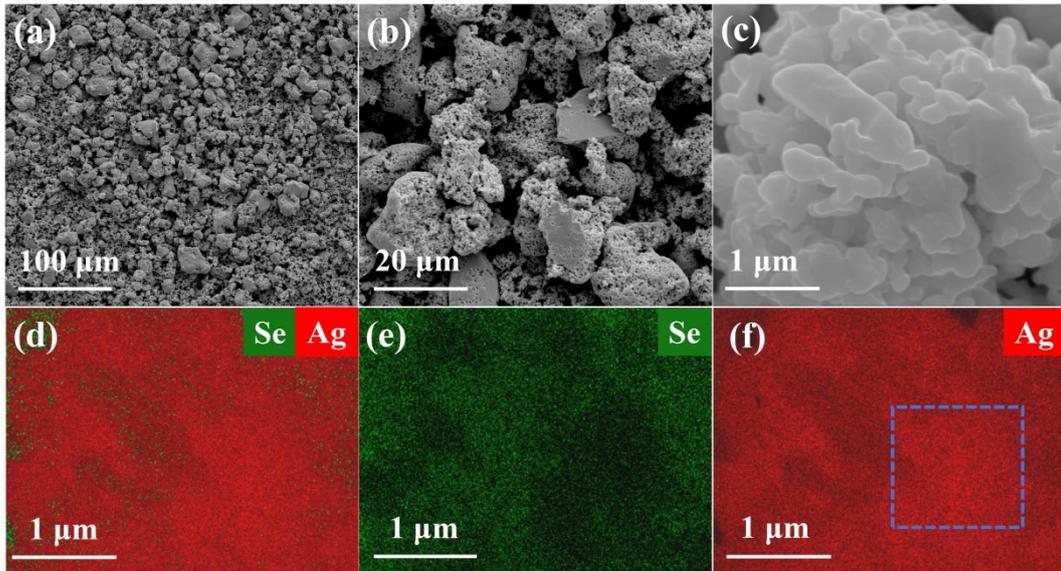


Figure S2 (a) Low and (b) high magnification SEM images of  $\text{Ag}_{2.2}\text{Se}$  TE film; (c) SEM image of  $\text{Ag}_{2.2}\text{Se}$  TE film and SEM-EDS mapping images: (d) overlap, (e) Se, (f)

Ag

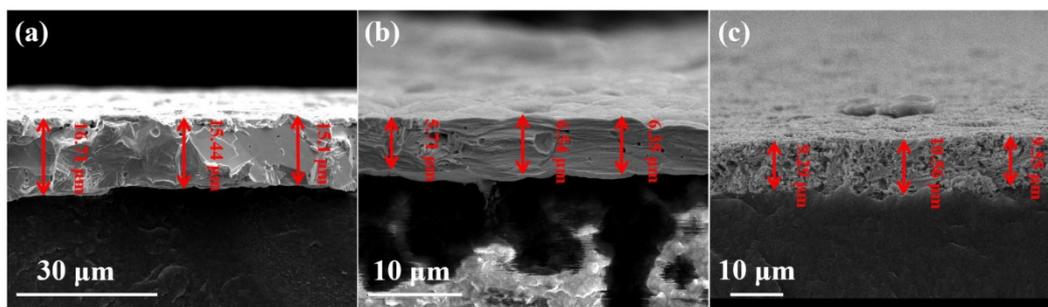


Figure S3 Cross-sectional SEM images of two-step post-treated  $\text{Ag}_2\text{Se}$  based TE films:

(a) CA- $\text{Ag}_{1.6}\text{Se}$ , (b) CA- $\text{Ag}_2\text{Se}$ , and (c) CA- $\text{Ag}_{2.2}\text{Se}$

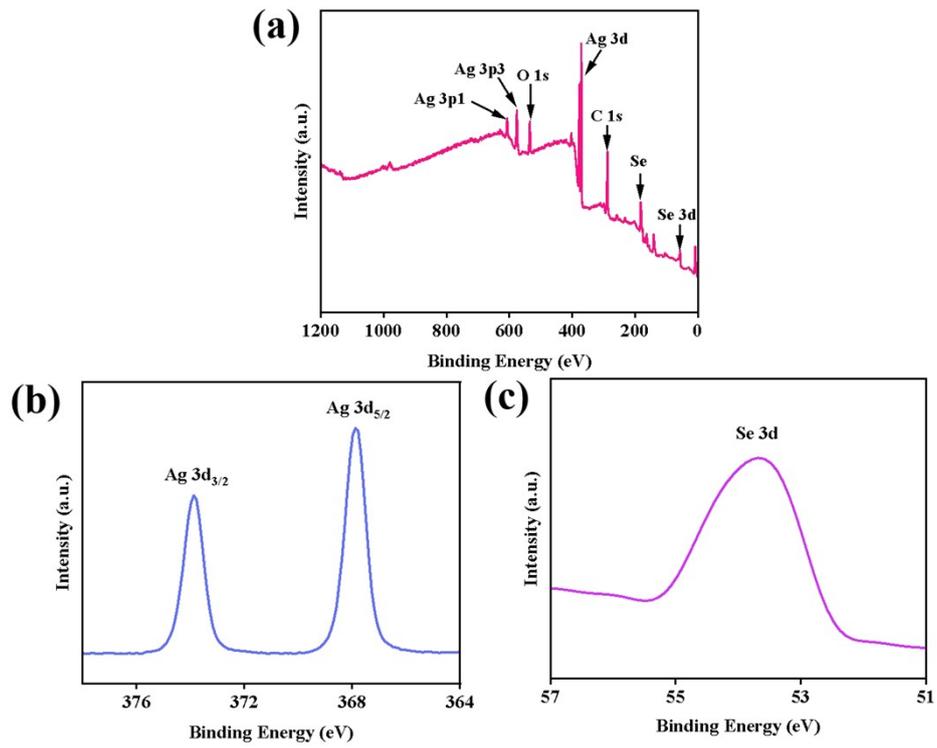


Figure S4 XPS spectra of CA-Ag<sub>2.2</sub>Se TE film: (a) full, (b) Ag 3d, (c) Se 3d

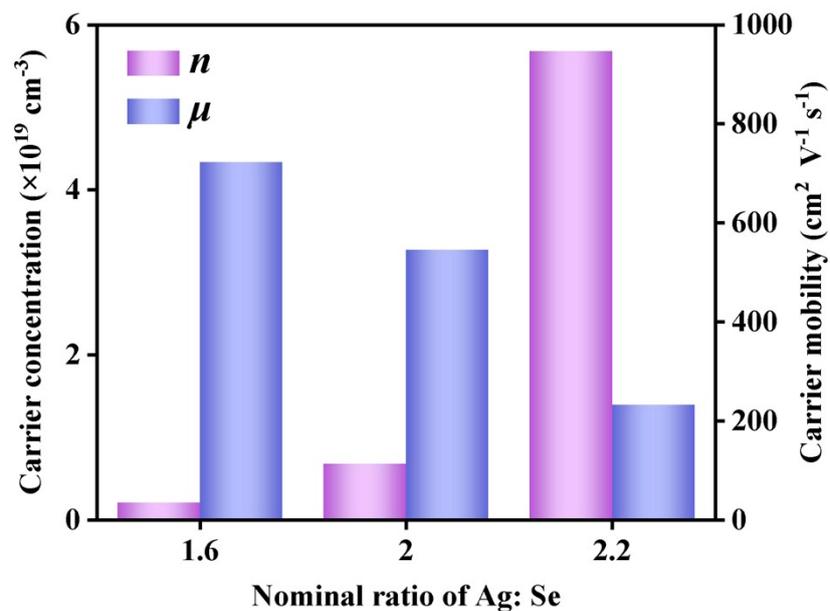


Figure S5 Carrier concentration and mobility of two-step post-treated  $\text{Ag}_2\text{Se}$ -based TE films with different molar ratio of Ag:Se

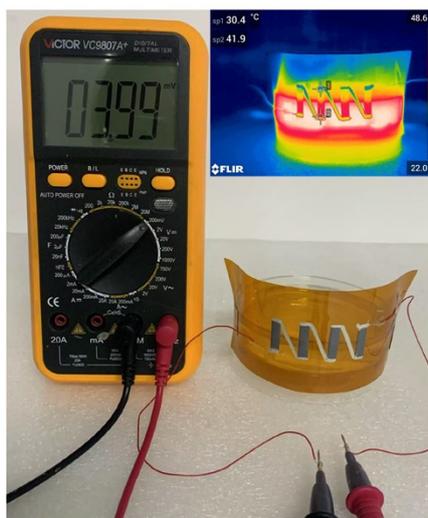


Figure S6 Digital photograph of application demonstration of flexible CA-Ag<sub>2.2</sub>Se TEG. The inset was the corresponding thermal imaging image