

Supplementary material for
Intrinsic lamellar defects containing atomic Cu in Cu_2X ($\text{X}=\text{S}$, Se) thermoelectric materials

Yuyu Wei^{a,b}, Ping Lu^{*,a,b}, Chenxi Zhu^{a,b}, Kunpeng Zhao^c, Xiaoyue Lu^{a,b}, Hong Su^{a,b},
Xun Shi^{a,b}, Lidong Chen^{a,b}, Fangfang Xu^{*,a,b,d}

^a State Key Laboratory of High Performance Ceramics and Superfine Microstructures, Shanghai Institute of Ceramics, Chinese Academy of Sciences (CAS), Shanghai 200050, China

^b Center of Materials Science and Optoelectronics Engineering, University of Chinese Academy of Sciences, Beijing 100049, China

^c State Key Laboratory of Metal Matrix Composites School of Materials Science and Engineering Shanghai Jiao Tong University Shanghai 200240, China

^d School of Physical Science and Technology, ShanghaiTech University, Shanghai 200031, China

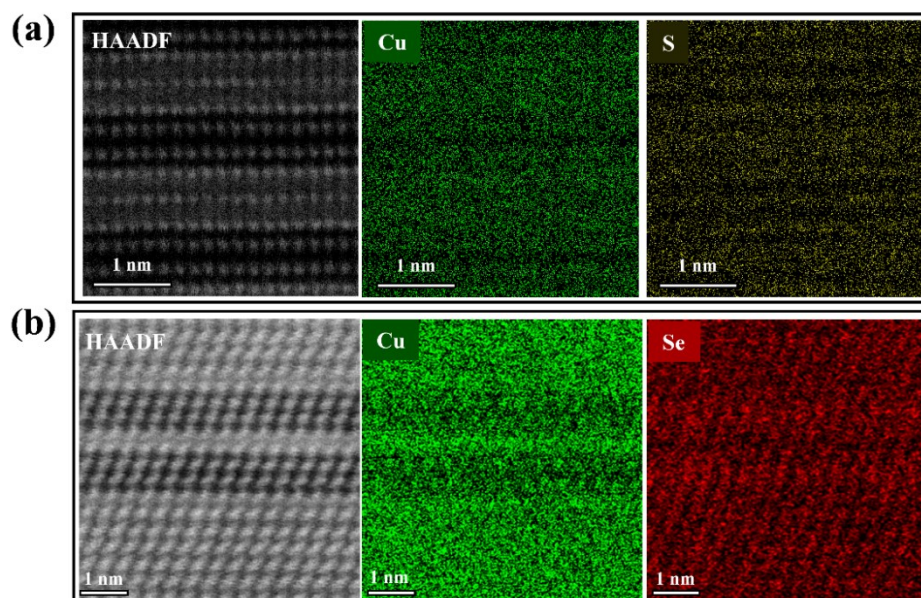


Figure S1. Compositional analysis of the lamella defects by EDS in Cu_2S and Cu_2Se :
(a) HAADF image, Cu and S EDS maps in Cu_2S , respectively, obtained with conditions of probe size in UHR mode. The absence of Cu elements at the lamella defects can be identified by the weaker signal intensity. However, the undulation of the S element is not obvious. (b) HAADF image and elemental maps of Cu and Se in Cu_2Se , respectively, obtained with conditions of probe size in HR Mapping mode. At the defects of Cu_2Se , the absence of copper accompanied by an enrichment of selenium are visualized.

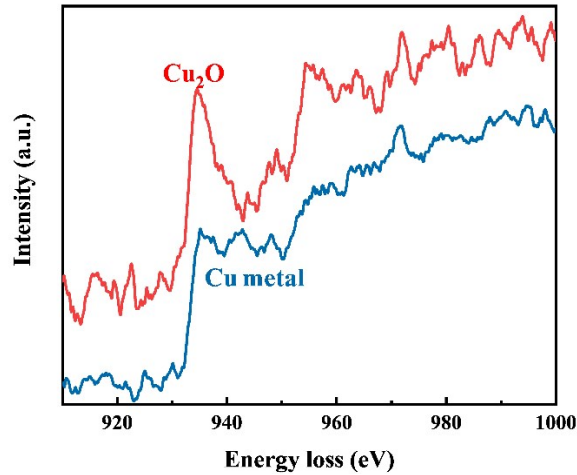


Figure S2. Experimental ELNES Cu-L₂₃-edges of standard Cu metal and Cu₂O. The Cu metal (99.98%) was sampled by ion milling. The Cu₂O (99.9%) was ground and dispersed on a nickel mesh with microporous carbon film. The spectra were acquired in STEM using spot modes with dual EELS. The convergence semi-angle, the collection angles and entrance aperture were the same as those in all EELS acquisition of Cu₂S_{0.5}Se_{0.5}. The energy dispersions were all 0.1eV/channel in spectra of Cu metal and Cu₂O. The spectra are presented after background subtraction using the power law model and smoothed under a condition of w=2 using Gatan Micrograph software package.

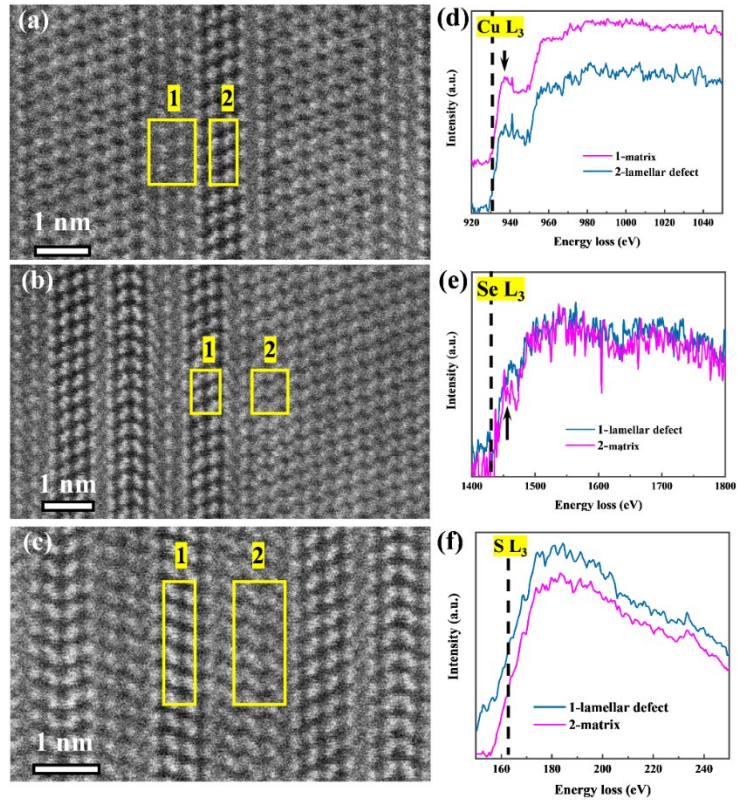


Figure S3. The core-loss regions of EEL spectra in lamella defects and matrix obtained from other areas of the Cu₂S_{0.5}Se_{0.5} sample. (a), (b) and (c) are HAADF

images where the regions for EELS are framed and the EEL spectra are presented in (d), (e) and (f), respectively.