

Supporting Information

Bandgap tunable colloidal Cu-based ternary and quaternary chalcogenide nanosheets *via* partial cation exchange

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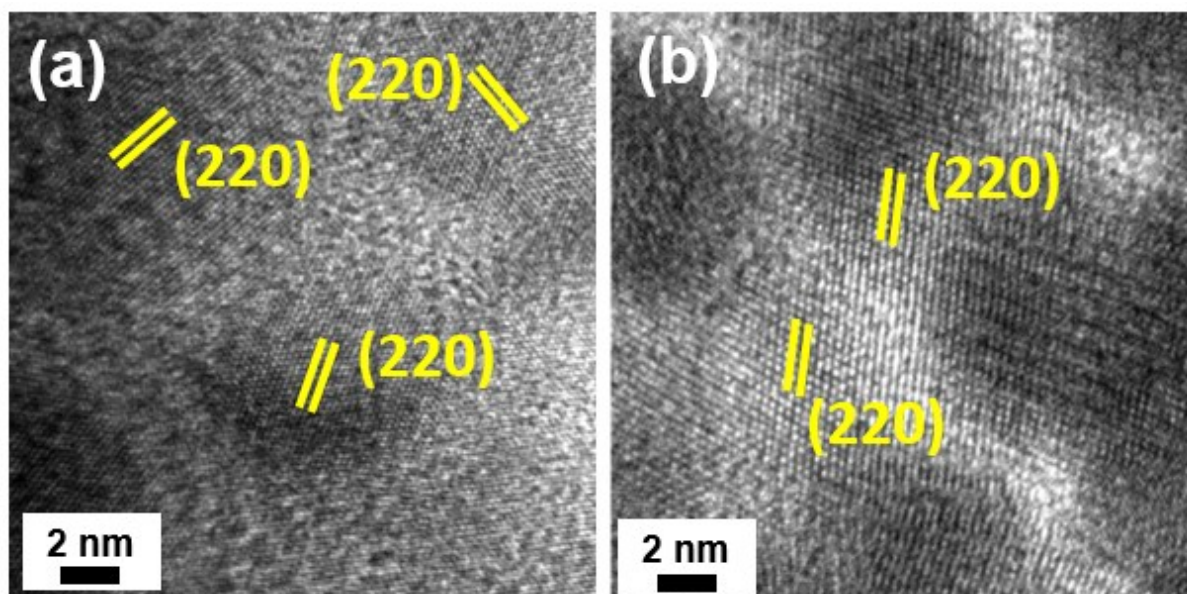


Fig. S1 HRTEM images of Cu_{2-x}Se NSs synthesized at 150 °C for 2h.

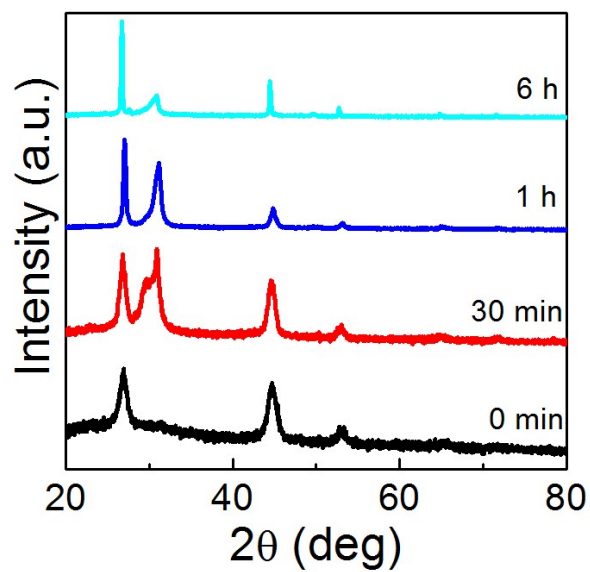


Fig. S2 XRD patterns of Cu_{2-x}Se nanostructures synthesized at different reaction times at 150 °C.

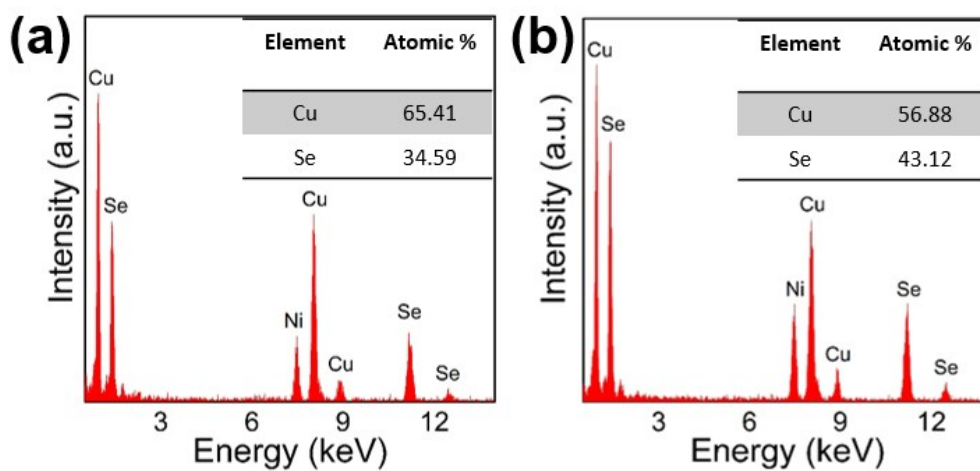


Fig. S3 EDS spectra of Cu_{2-x}Se NSs synthesized at (a) 0 and (b) 30 min.

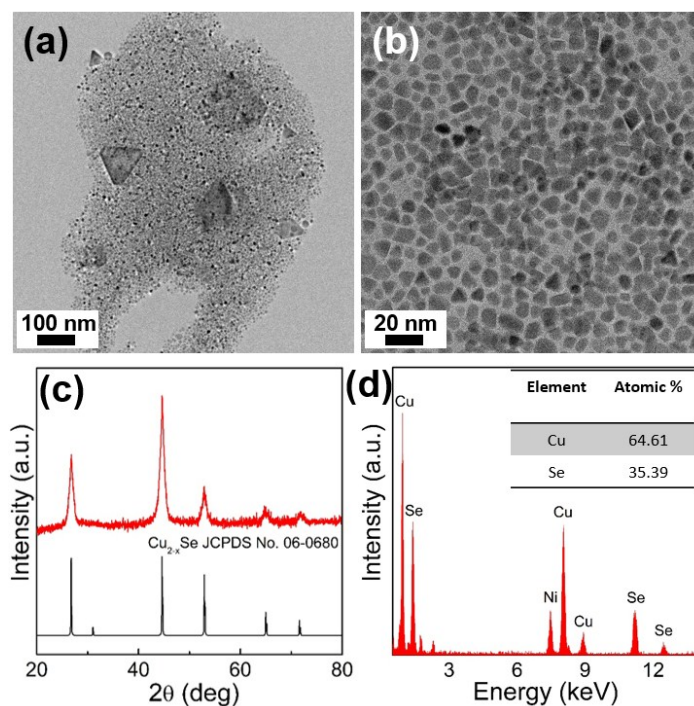


Fig. S4 (a, b) TEM images (c) XRD pattern and (d) EDS spectrum of Cu_{2-x}Se nanoparticles synthesized at $150\text{ }^\circ\text{C}$ for 2h using Se precursor prepared under inert condition.

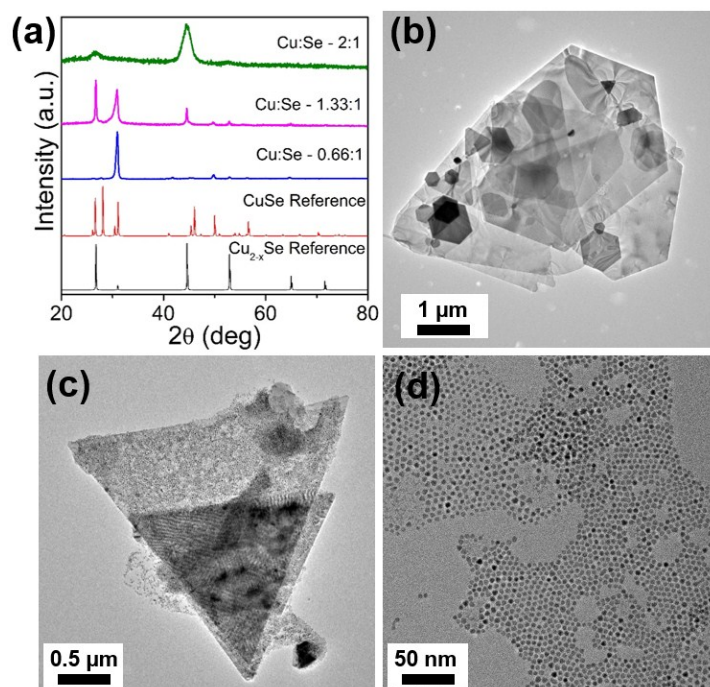


Fig. S5 (a) XRD patterns and (b-d) TEM images of copper selenide nanostructures synthesized at $150\text{ }^\circ\text{C}$ for 2 h with different molar ratios of Cu^+ to Se powder. (b) 0.66:1, (c) 1.33:1 and (d) 2:1.

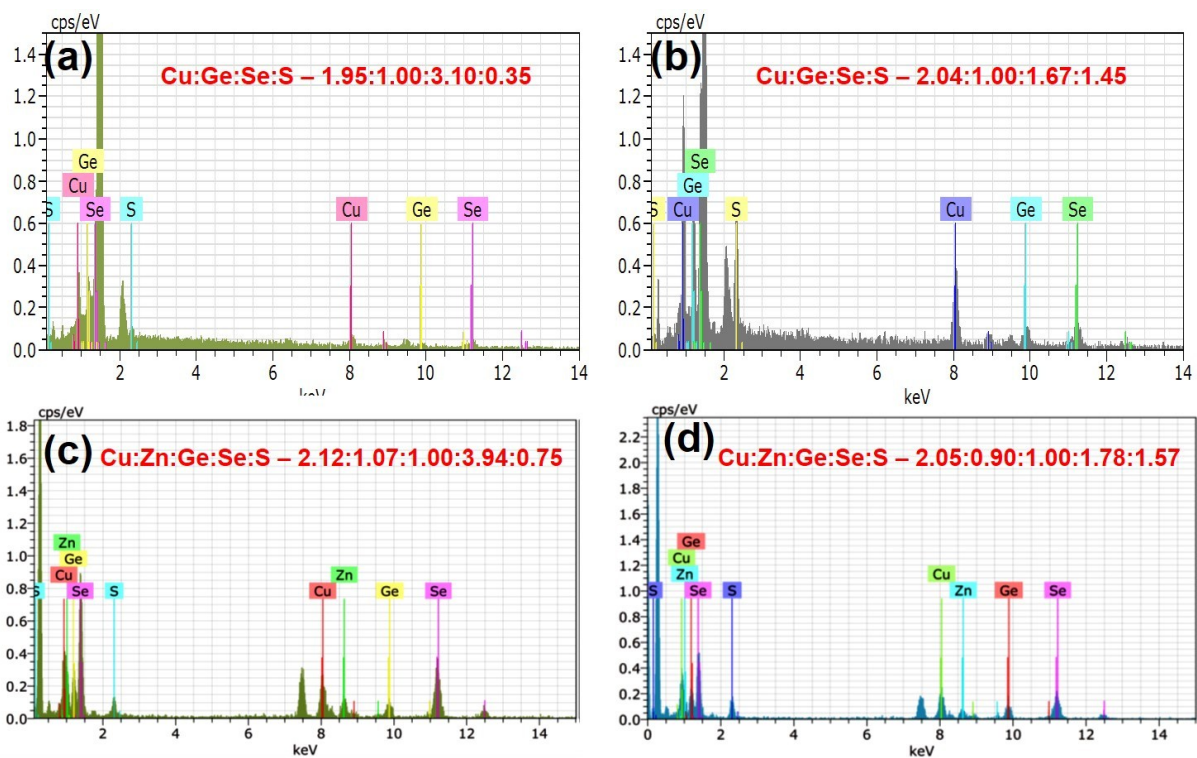


Fig. S6 EDS spectra of (a) CGSe, (b) CGSSe, (c) CZGSe and (d) CZGSSe nanosheets.

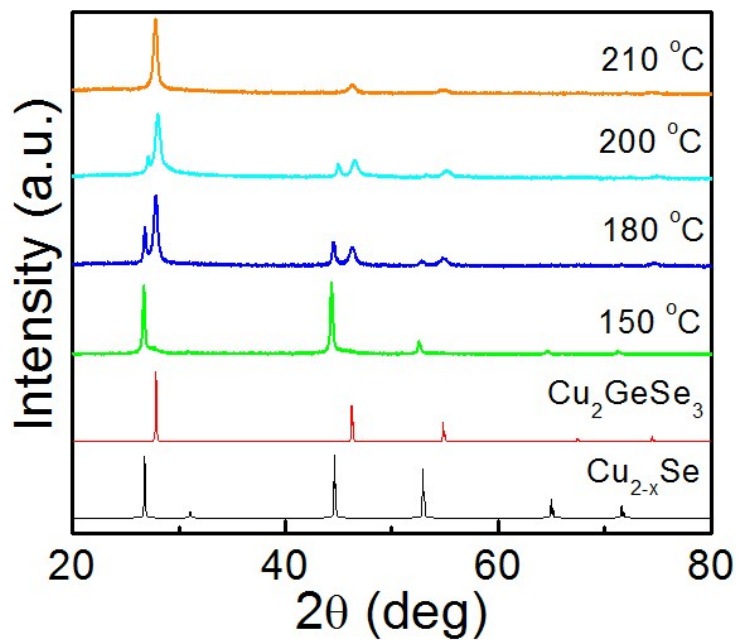


Fig. S7 XRD patterns of CGSe nanosheets obtained at different cation exchange reaction temperatures.

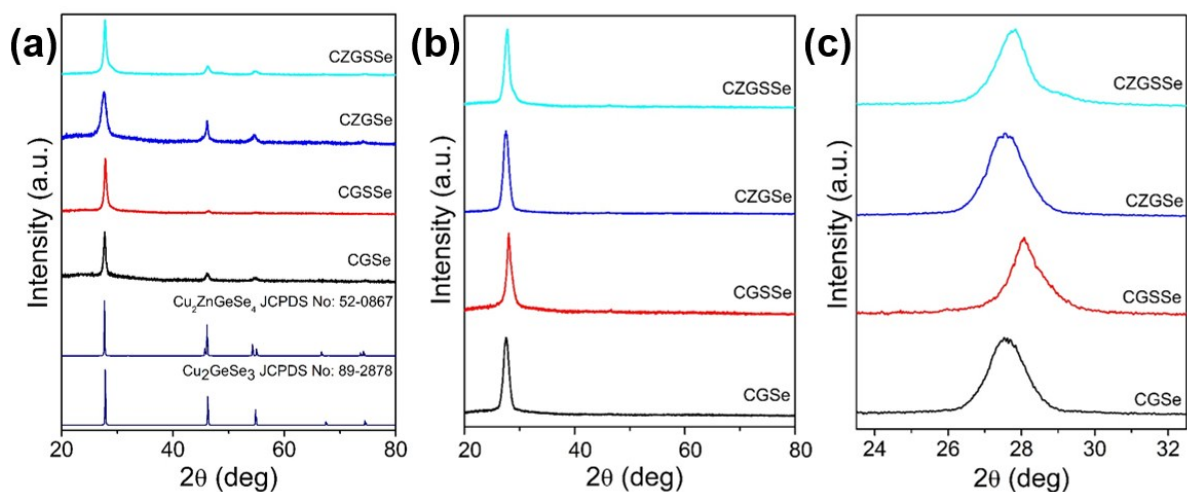


Fig. S8 XRD patterns of CGSe, CGSSe, CZGSe and CZGSSe nanosheets. (a) thick films, and (b) drop casted thin film. (c) shows the (111) peak position to highlight the peak shifting when sulfur added to the nanosheets.

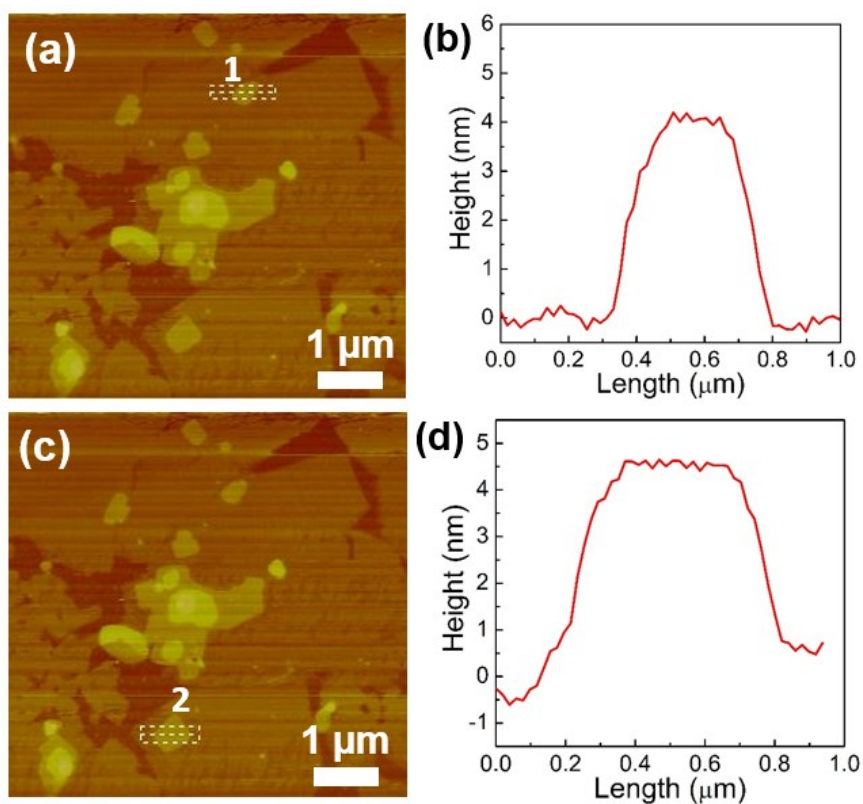


Fig. S9 AFM image and height profiles of CGSe nanosheets measured at two different places.

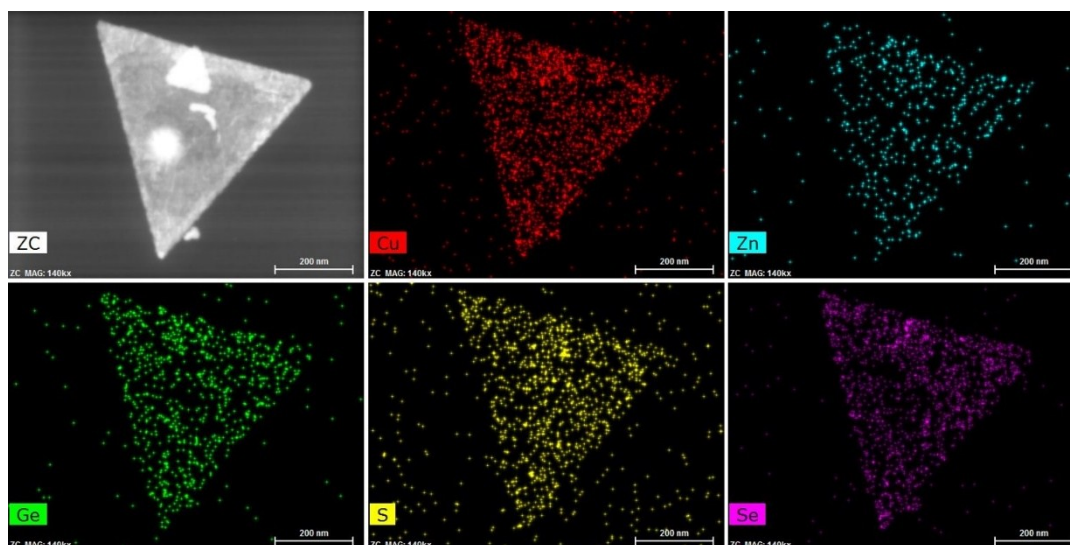


Fig. S10 STEM-EDS elemental mappings of CZGSSe nanosheets.

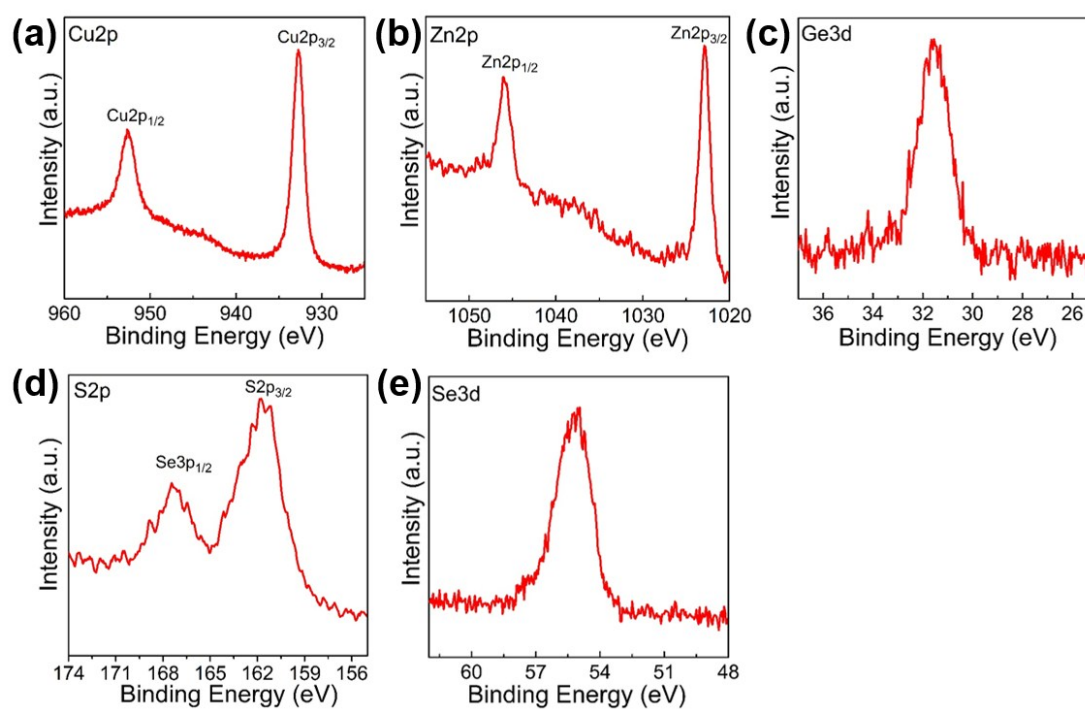


Fig. S11 XPS spectra of CZGSSe nanosheets.

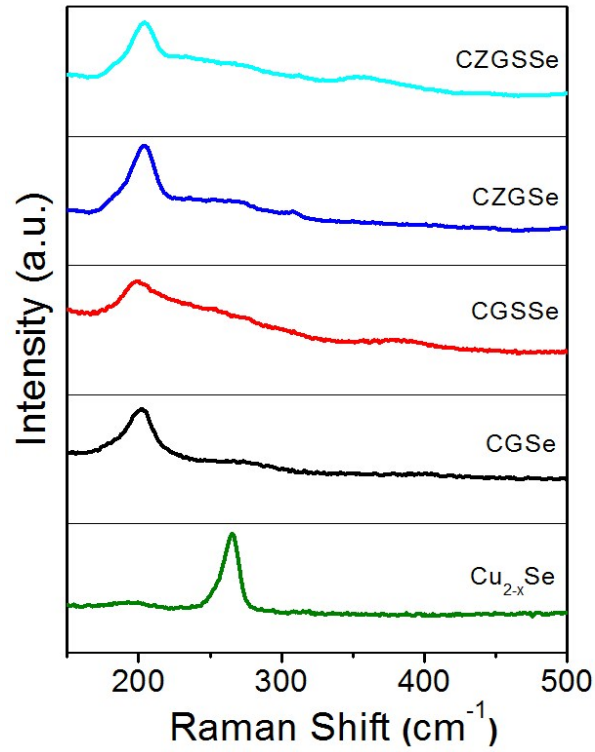


Fig. S12 Raman spectra of Cu_{2-x}Se , CGSe, CGSSe, CZGSe and CZGSSe nanosheets.

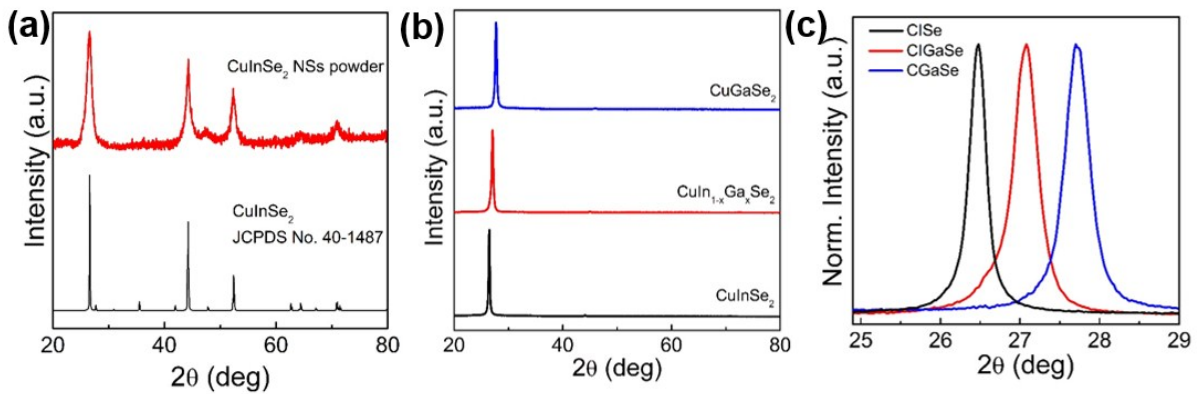


Fig. 13 XRD patterns of CuInSe_2 powder sample. XRD patterns of CuInSe_2 , $\text{CuIn}_{1-x}\text{Ga}_x\text{Se}_2$ and CuGaSe_2 nanosheets thin films. (c) shows the (111) peak position to highlight the peak shifting with increasing Ga concentration.