Electronic Supplementary Material (ESI) for RSC Advances.

Citric acid tuned negative thermal quenching of all inorganic copper-based perovskites

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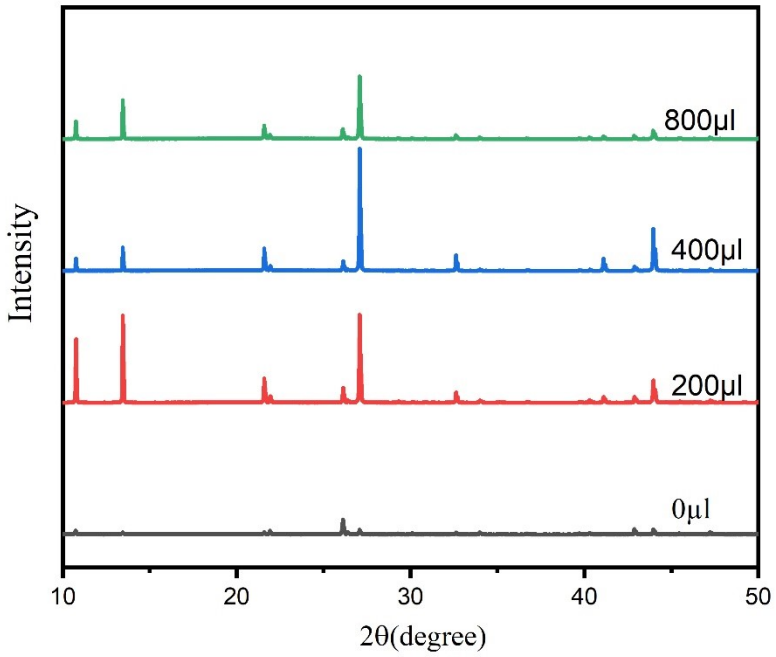

Figure S1 Structural analysis of $CsCu_2I_3$ with OA as the chelating agent. It can be observed from the figure that the peak intensity grows with the increasing of OA. All samples are pure $CsCu_2I_3$ phase, which are consistent with the (PDF#45-0076) cards.

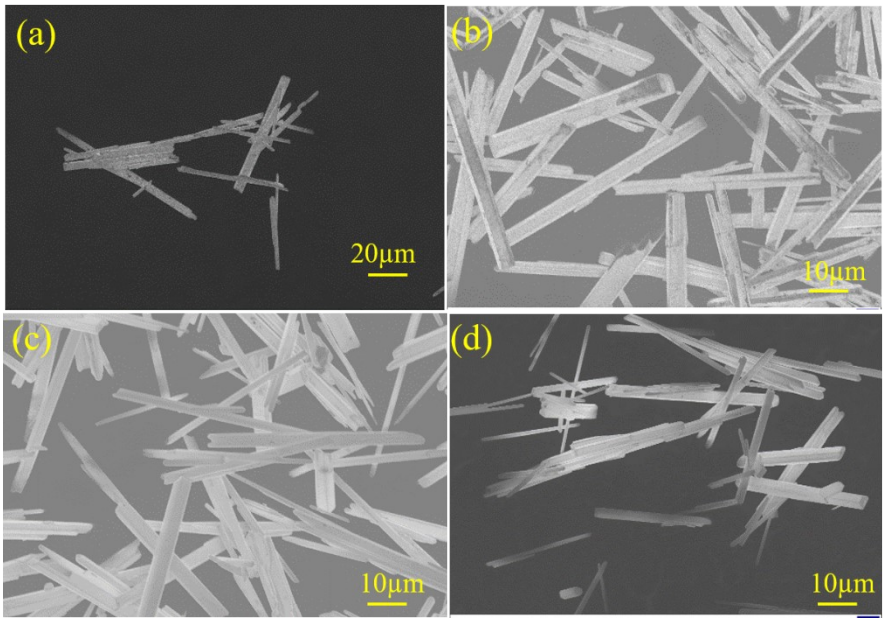

Figure S2 Morphology analysis of the $CsCu_2I_3$ with different OA((a) 0 μl, (b) 200 μl, (c) 200 μl, (d) 800 μl) amount. From the SEM images, it can be observed that all the samples are hexagonal columns with the size of about 200 μm-300 μm. therefore, it can be concluded that the peak intensity increasing of the XRD result are attributed to the better crystallinity.

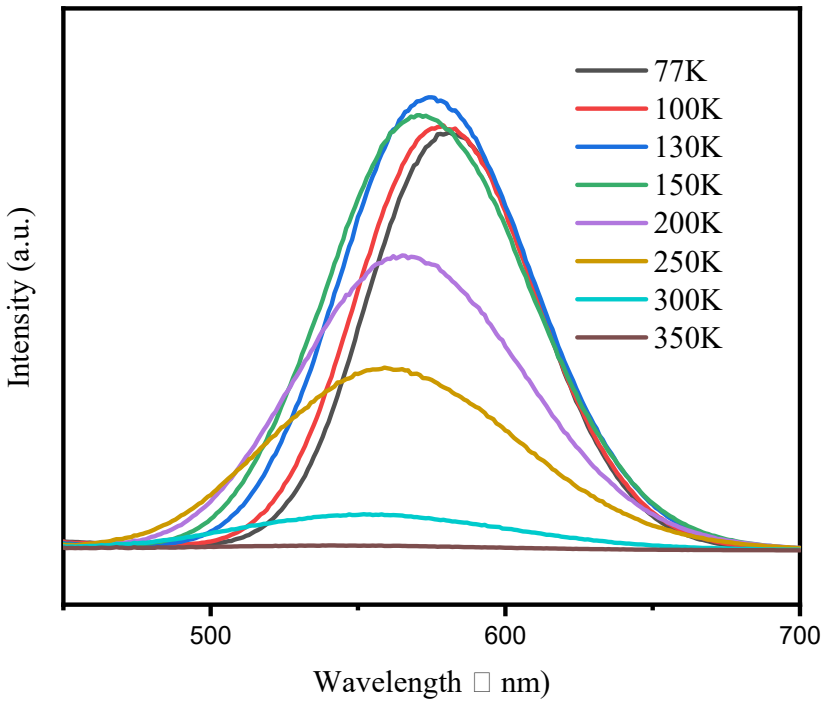

Figure S3 Temperature dependent emission spectra of the sample It can be seen from the figure that the highest intensity has been obtained at about 130 K, which is much lower than that of $CsCu_2I_3$ films.

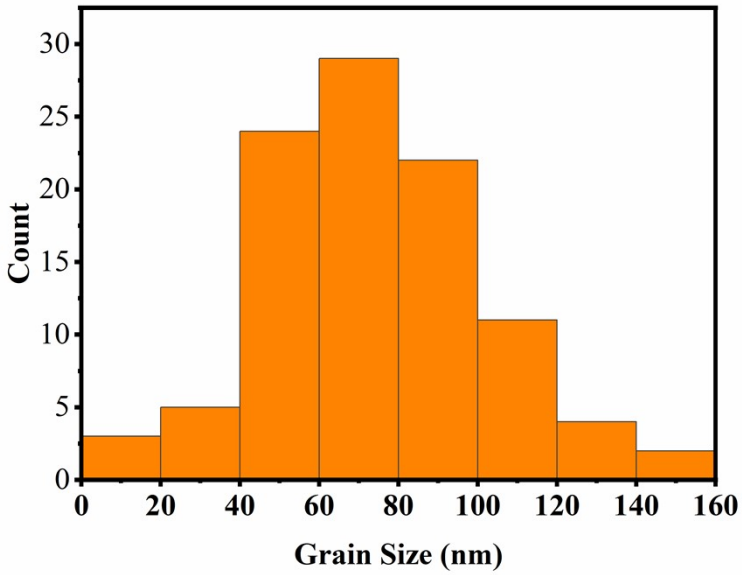

Figure S4 Grain size distribution of as-prepared $CsCu_2I_3$ films with Cit 0 mmol

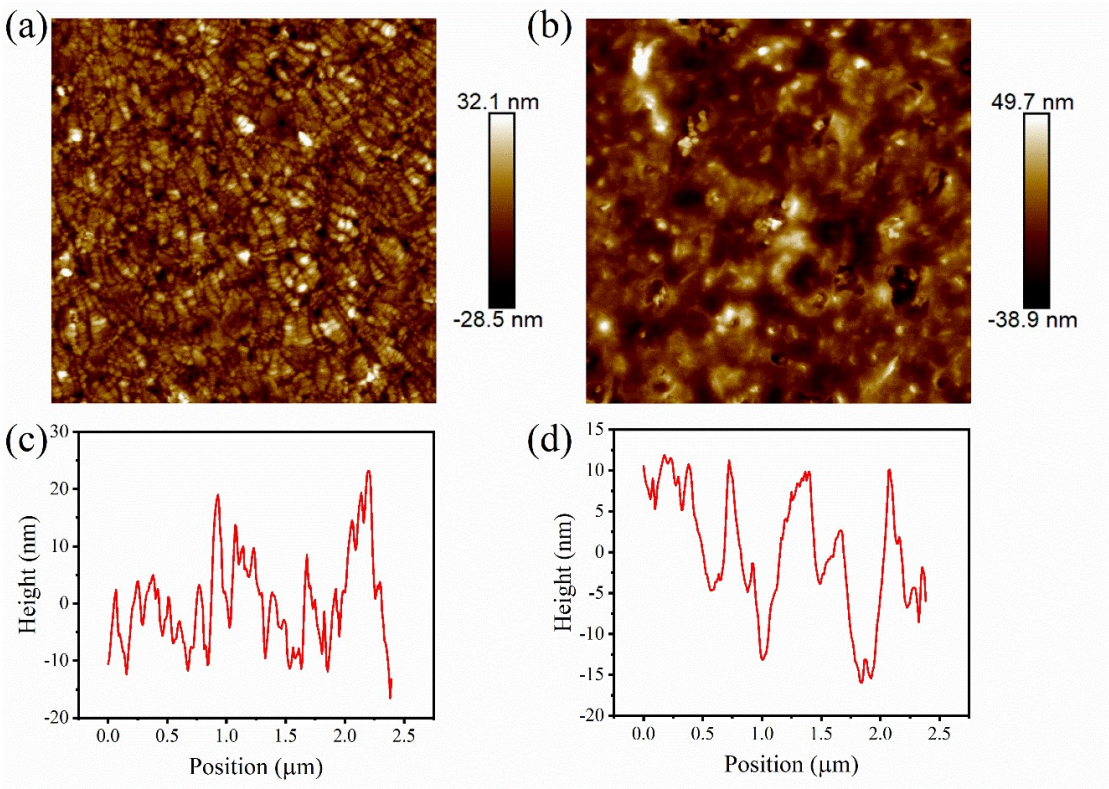

Figure S5 AFM images and roughness of the as-prepared $CsCu_2I_3$ films with Cit 0 mmol (a,c) and Cit 1 mmol (b,d). With Cit 0 mmol, a grain size of about 74 nm was obtained, and with Cit 1 mmol, it is hard to seen the grain boundary. According to AFM measurements, the RMS roughness for the sample with Cit 0 mmol and 1 mmol are 8.04 nm and 12 nm separately, which are no obvious different.

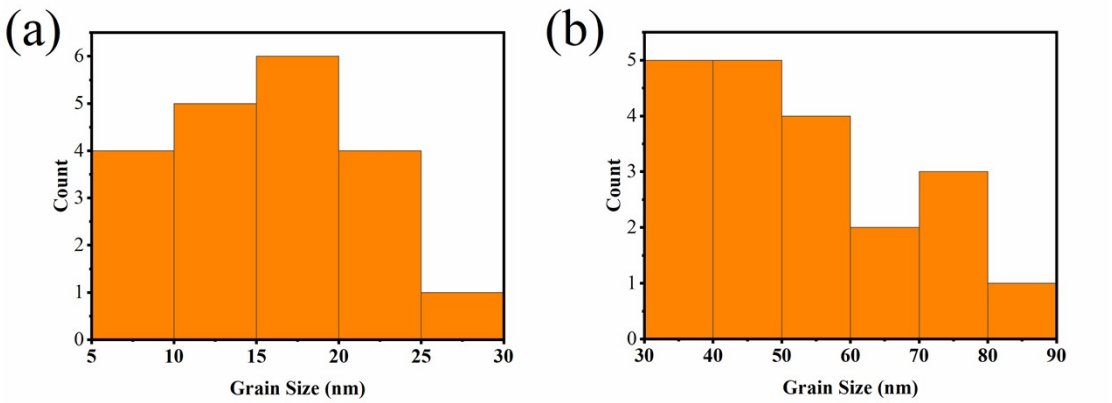

Figure S6 Particle size distribution of the as-prepared $CsCu_2I_3$ micro-crystals with Cit 0 mmol (a) and cit 1 mmol (b)

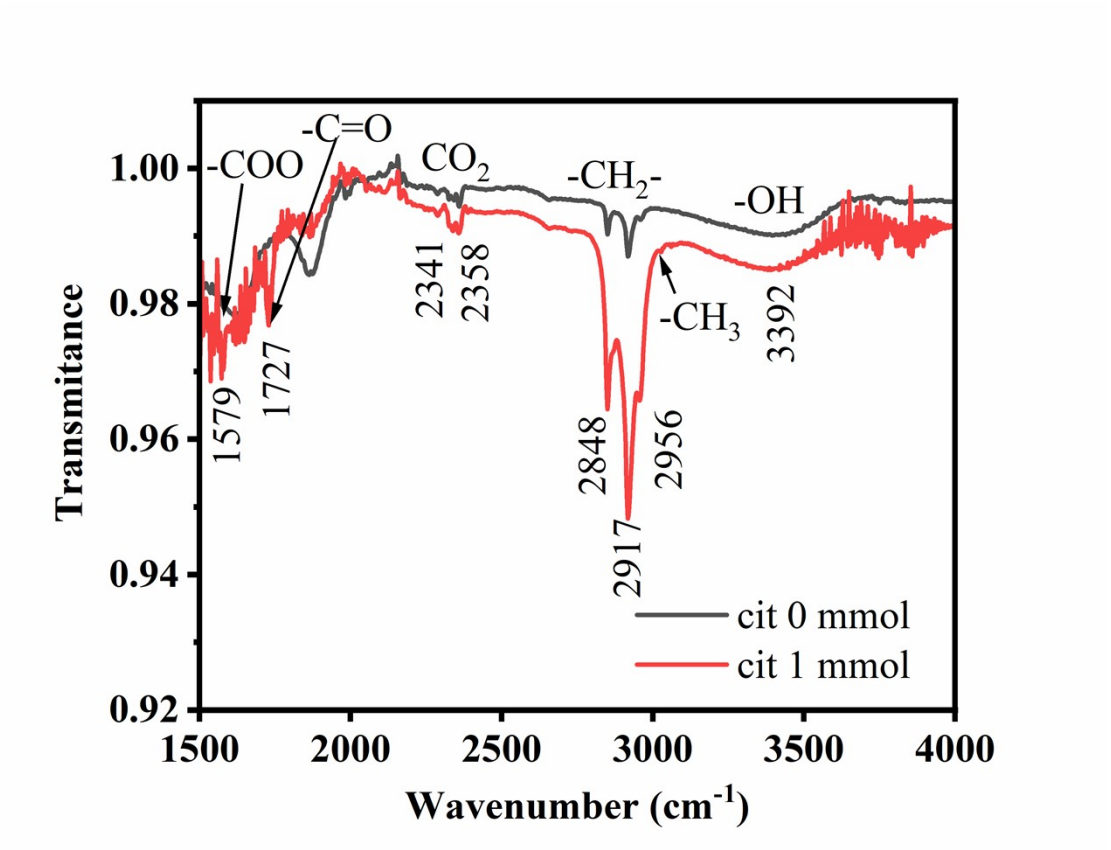

Figure S7 FTIR spectra of the as-prepared $CsCu_2I_3$ films with Cit 0 mmol and Cit 1 mmol. Because the films are growth on silicons, only a weak absorption peak can be observed from the FTIR experiments The characteristic vibration bands of (–OH) group are centered at 3392 cm^{-1}, which is due to the absorbed ambient water. The antisymmetrical (1579 cm^{-1}) peaks are linked to the carboxyl group of Cit anions or molecules. The vibration bands of –C=O centered at 1727 cm^{-1} are derived from the monomeric COOH. Three vibration bands at 2848 to 2956 cm^{-1} are related to CH_2 group [1,2].

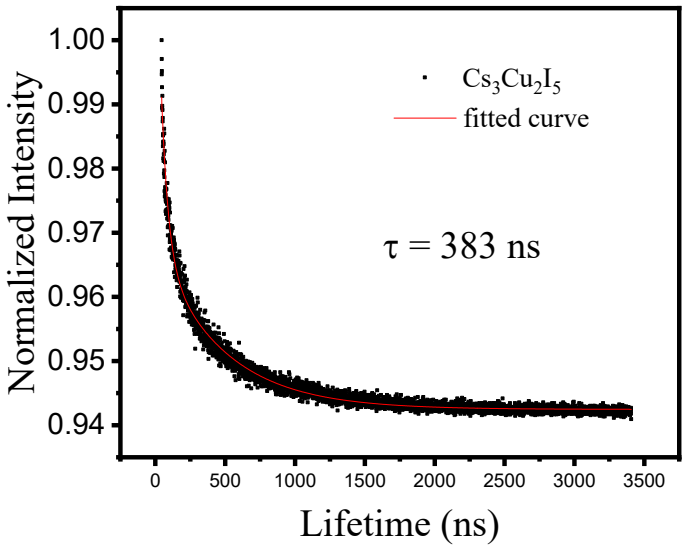

Figure S8 Lifetime of $Cs_3Cu_2I_5$ phase (excited at 290 nm, emission at 440 nm)

References

[1]GASGNIER, J. Mater. Sci. Lett. 20 (2001) 1259–1262.

[2] Lee, R. Condrate, J. Mater. Sci. 34 (1999) 139–146.