

# ゲル浸透クロマトグラフィーを用いた配向性を有する非鉛 $\text{Cs}_3\text{Cu}_2\text{I}_5$ 単結晶膜の開発

## Highly oriented Lead-Free $\text{Cs}_3\text{Cu}_2\text{I}_5$ Single Nanocrystal Film via Gel Permeation Chromatography Purification

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The emergence of environment friendly materials has attracted considerable attention in the field of optoelectronics. Copper-based lead-free halide perovskite (with a near-unity quantum yield) obtained from  $\text{Cs}_3\text{Cu}_2\text{I}_5$  can exhibit blue emission with a wavelength of 440 nm and provide outstanding stability for various applications. However, in practical applications, colloidal dispersion purity and film quality are still an issue to make a quality thin film for a device.

In this study, an antisolvent-free gel permeation chromatography (GPC) is first used to purify lead-free  $\text{Cs}_3\text{Cu}_2\text{I}_5$  nanocrystals (NCs). The purified  $\text{Cs}_3\text{Cu}_2\text{I}_5$  NCs exhibit completely eliminated impurities from NMR spectra (Fig. 1). The  $\text{Cs}_3\text{Cu}_2\text{I}_5$  NCs also exhibit a high photoluminescent quantum yield (~100% in a colloidal solution and 79.3% in a film) and provide a highly oriented single-crystal film (Fig. 2). Density functional theory (DFT) calculation results showed that the surface energy  $\text{Cs}_3\text{Cu}_2\text{I}_5$  was the lowest at (020) owing to the high phase stability in the film. Finally, it has been demonstrated for the first time that the mixture of polymethyl methacrylate (PMMA) and  $\text{Cs}_3\text{Cu}_2\text{I}_5$  NCs has waterproofing capabilities. The composite film consisting of  $\text{Cs}_3\text{Cu}_2\text{I}_5$  NCs and PMMA can survive in water for at least 10 days. This result opens up more possibilities for the application of these NCs.

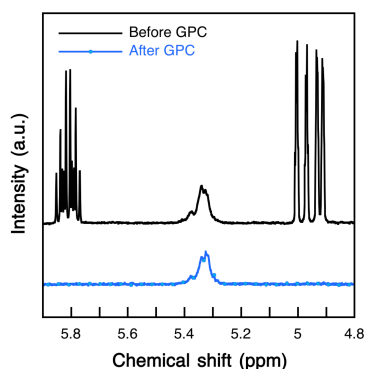


Fig. 1 The NMR spectra of NCs colloid before and

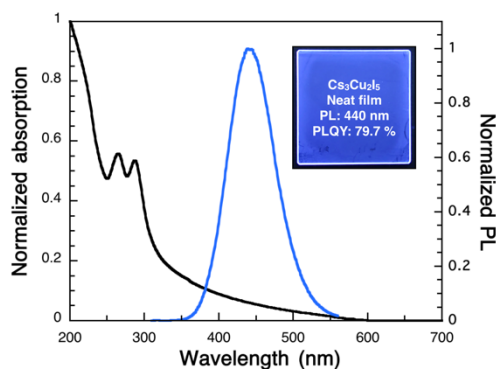


Fig. 2 Absorption, emission spectra and film