Electronic Supplementary Information (ESI)

Synthesis and Luminescence of Mn-Doped $Cs_2AgInCl_6$ Double Perovskite†

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Experimental

Chemicals: Hydrochloric Acid (HCl, 37 wt %), Cesium Chloride (CsCl, 99.9%), Indium (III) Chloride ($InCl_3$, Anhydrous powder, ≥99.999%), Silver Chloride (AgCl, 99.999%) and Manganese Chloride ($MnCl_2$, ≥99%) are purchased from Sigma Aldrich Chemicals. All the precursors are used as received without any further purification.

Characterization: All samples are grounded into fine powder before performing any analysis. ICP- AES analysis is carried out using ARCOS simultaneous ICP spectrometer, SPECTRO

Analytical Instruments GmbH, Germany. Field Emission Scanning Electron Microscopy (FESEM) measurements are recorded by a Zeiss Ultra Plus Field Emission SEM instrument. Powder X-Ray Diffraction (XRD) measurements are carried out using a Bruker D8 Advance X-ray diffractometer equipped with Cu Kα radiation of wavelength 1.54 Å. All samples are ground into fine powder and placed on glass sample holders. Thermo gravimetric (TGA) analyses are performed on Perkin Elmer STA 6000. All samples are heated in a temperature range of 30- 800 ºC at a 10 ºC/ min heating rate under inert atmosphere. UV-visible diffuse reflectance spectra (DRS) were collected from Shimadzu UV 3000 600Plus UV-Vis/NIR Spectrophotometer in the range of 200 nm- 800 nm. DRS are converted by Kubelka – Munk function to estimate absorbance values. Steady state photoluminescence (PL) and PL decay dynamics are obtained from FLS 980, Edinburg Instrument. For recording PL decay dynamics, samples are excited at 340 nm using a microsecond flash lamp of 100 W power. Electron Paramagnetic Resonance (EPR) spectroscopy is carried out using a JES- FA200 ESR spectrometer (JEOL, Japan) in X band frequency range.

PL quantum yield for Mn-emission was measured using Rhodamine 6G dye as a reference dye. Both dye and sample (0.9% Mn doped $Cs_2AgInCl_6$) were dispersed in 8.8 w% Poly(methyl methacrylate) - toluene solution and coated on quartz substrate. These films were dried and used for the measurement of reference quantum yield. To minimize the errors coming from inhomogeniety in film thickness, pinholes etc, we have measured absorption and PL data from 10 different spots of the same film, and the averaged out value for absorbance and PL intensity were used for the calculation of reference quantum yield. A more reliable number of absolute quantum yield is required to be measured in future using integrating sphere.

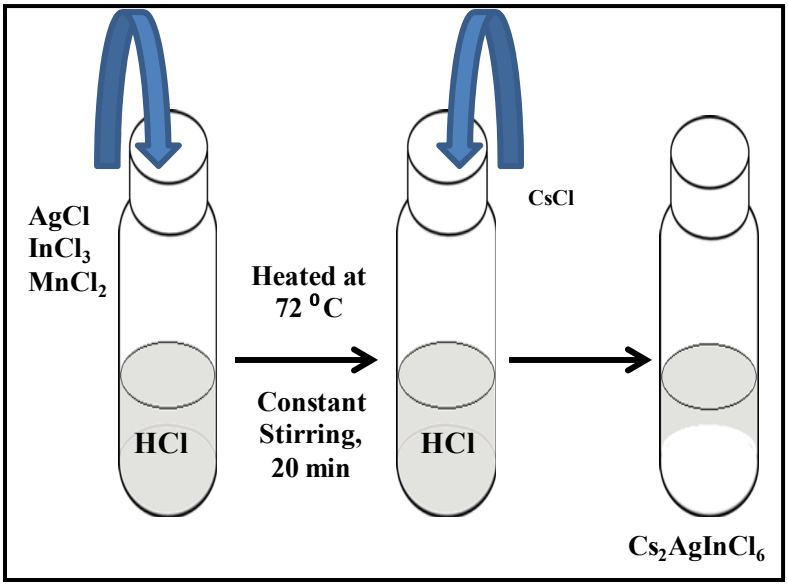

Figure S1: Schematics representation of the synthesis procedure of Mn-doped $Cs_2AgInCl_6$.

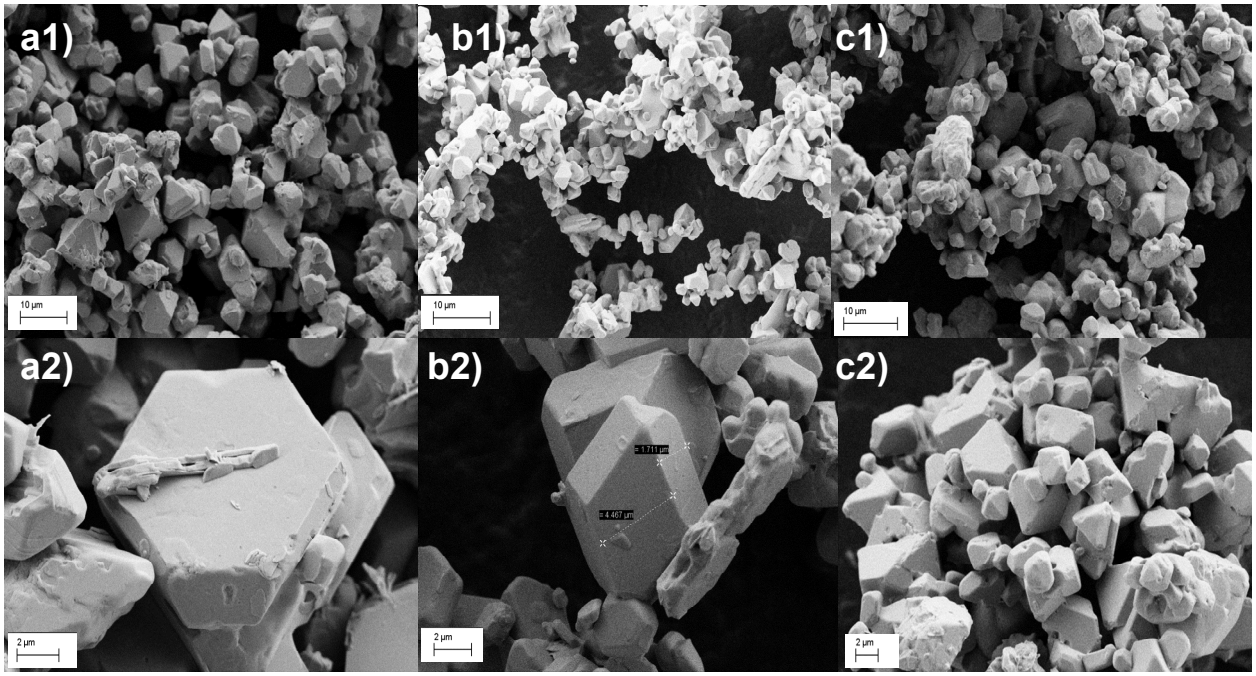

Figure S2: FESEM images of (a1-a2) 0.1%, (b1-b2) 0.3% and (c1-c2) 0.9% Mn-doped $Cs_2AgInCl_6$. Top images have a magnification of 10 µm and bottom images 2 µm.

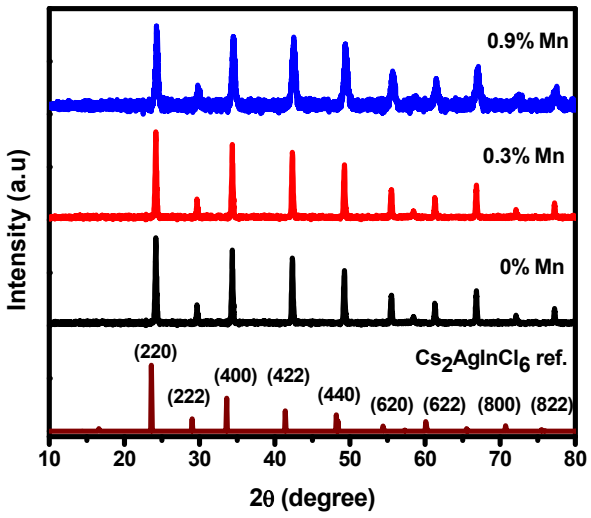

Figure S3: XRD patterns of Mn-doped $Cs_2AgInCl_6$ after storing the samples for three months in ambient conditions. These results suggest the long-term stability of our samples.

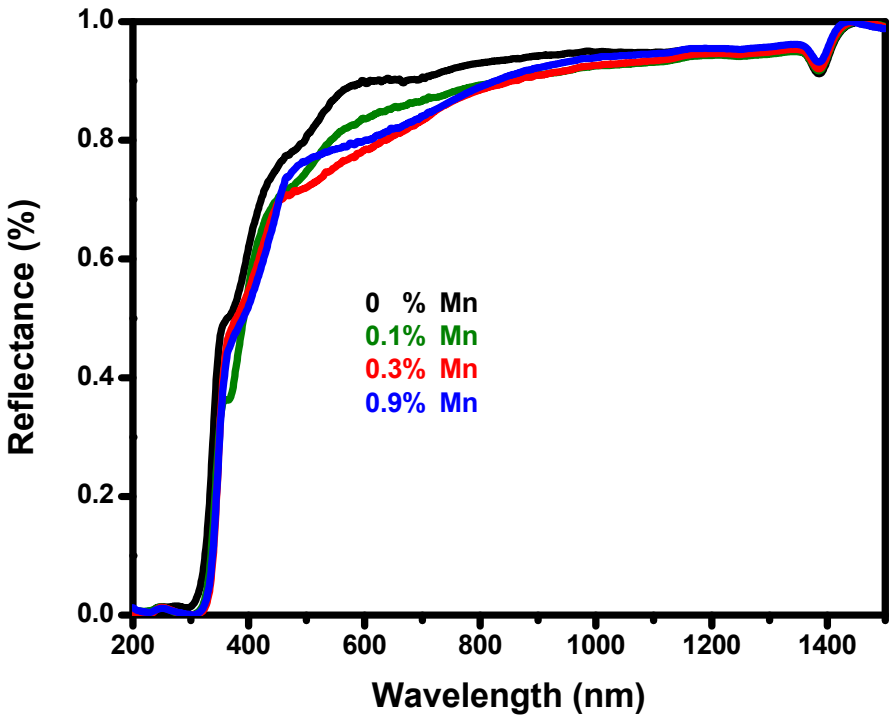

Figure S4: UV-Visible Diffuse Reflectance Spectra for 0%, 0.1%, 0.3% and 0.9% Mn-doped Cs2AgInCl6.

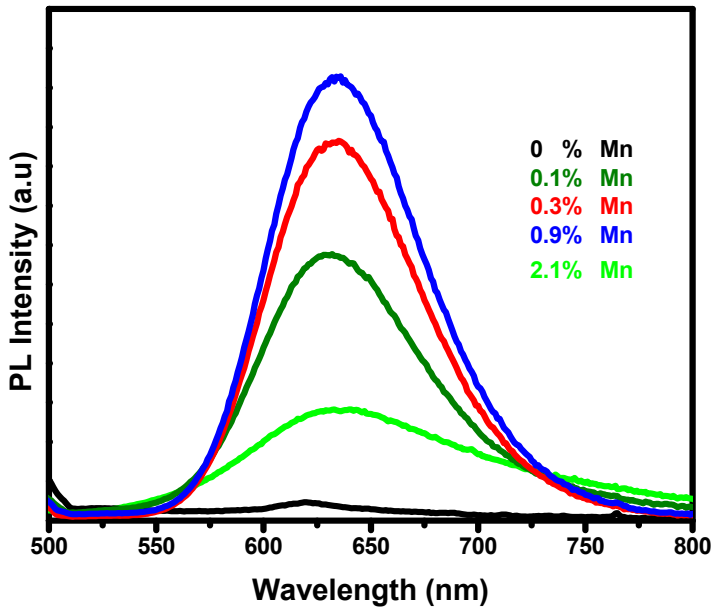

Figure S5: PL spectra of different Mn-doped $Cs_2AgInCl_6$. Maximum PL intensity is shown by 0.9% Mn-doped sample. Further increase in Mn concentration decreases the PL intensity.

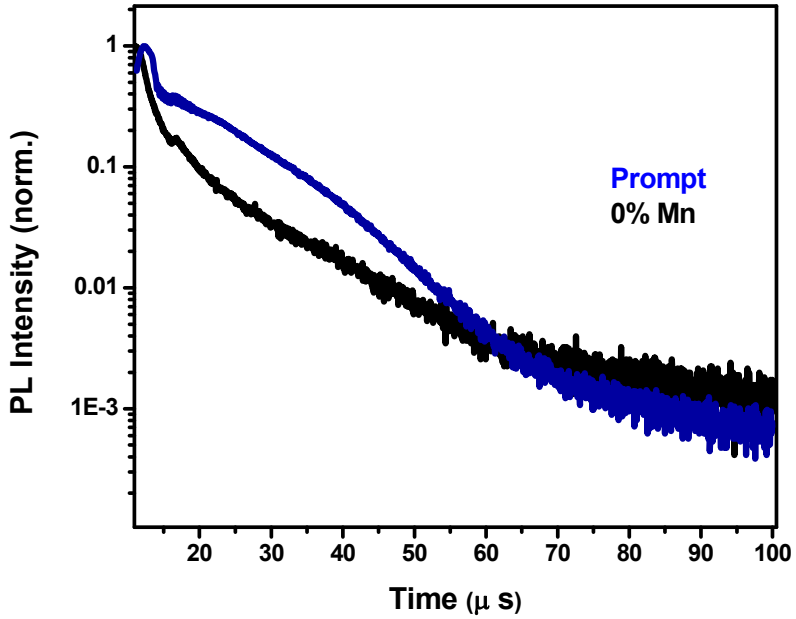

Figure S6: Recorded PL decay of undoped $Cs_2AgInCl_6$ and the instrument response function (prompt).