

Room temperature synthesis of hydrophilic, highly-fluorescent metal halide perovskite nanocrystals for biomedical applications

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Metal halide perovskite nanocrystals that have the chemical formula ABX_3 , where the “A”, “B” cations are located in corner positions of the unit cell and at the center of the cell respectively and “X” anion is situated at the unit cell faces, due to their interesting optical properties (high PLQY, narrow FWHM, intense fluorescence, tunable emission), are investigated as potential probes with high sensitivity and rapid sensing capability in the fields of bio-imaging, bio-sensing and drug delivery. Among the different chemical phases, the $CsPbBr_3$ all-inorganic perovskites has the highest luminescence and stability (Goldschmidt factor ~ 0.92), but still remain hydrophobic and unstable in biological buffers [1,2]. An effective way to overcome the previously addressed issues is the encapsulation of the fluorescent nanocrystals into an inert silica (SiO_2) shell which is non-toxic and transparent to visible spectrum. According to this, the aim of this research was to fabricate hydrophilic perovskite nanocrystals well dispersed in aqueous and biological media using room temperature protocols. Two different silica precursors were used in order to develop a robust SiO_2 shell around the perovskite cores ($CsPbBr_3$): TMOS ($Si(OCH_3)_4$) in which the hydrolysis takes place rapidly in four directions ($-OCH_3$) resulting in a denser matrix and MPTMS ($HS(CH_2)_3Si(OCH_3)_3$) with two functional groups, the $-OCH_3$ (hydrolysis \rightarrow denser shell) and $-SH$ ($-PbS$ bond \rightarrow stability between the shell and the core). The optimum precursor quantities as well as the appropriate order of the injection in the reactant solution were carefully investigated. The stability through the time of the-perovskite-based core-shell nanocrystals in water (Figure 1a-b) and biological buffer (Figure 1c) were studied through PL spectroscopy. The aqueous colloidal solutions remained PL active even after 7h. Transmission Electron Microscopy revealed the spherical $CsPbBr_3@SiO_2$ structures “bubble-like morphology”- where the perovskite nanocrystals were included.

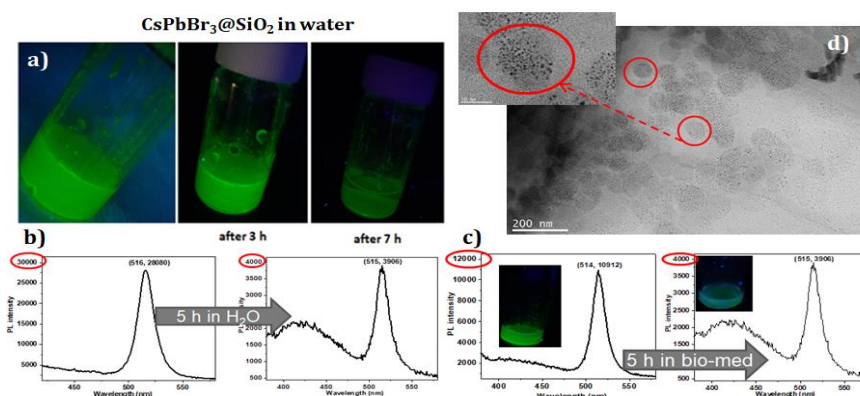


Figure 1: a) Aqueous dispersion of $CsPbBr_3@SiO_2$ nanoparticles upon time under UV lamp, b) PL spectra of the same solutions upon time, c) PL spectra of $CsPbBr_3@SiO_2$ nanoparticles in biological medium (HG DMEM with 10% FBS and 1% pIs), d) TEM images of $CsPbBr_3@SiO_2$ nanoparticles.

References

- [1] Hwang et al., *J Mater Chem C*, **6**, 972 (2018).
- [2] Lian et al. *Coordination Chemistry Reviews* **452**, 214313 (2022).