ELECTRONIC SUPPLEMENTARY INFORMATION

Quantum Dots Assembled from an Aziridinium Based Hybrid Perovskite Displaying Tunable Luminescence

Oleksandr A. Semenikhin, Olesia I. Kucheriv, Liviu Sacarescu, Sergiu Shova and Il'ya A. Gural'skiy

Materials and methods

Chemicals. Aziridinium, toluene, dimethyl sulfoxide (DMSO), hydrochloric acid and hydrobromic acid were obtained from UkrOrgSyntez Ltd. (Kyiv, Ukraine). Cetyltrimethylammonium bromide (CTAB), $PbBr_2$ and $PbCl_2$ were purchased from Acros Organics (Geel, Belgium) and used without any further purification.

Synthesis of quantum dots. and $(AzrH)PbCl_3$ had been obtained according to method described previously[1].

Br-QDs: The $(AzrH)PbBr_3$ perovskite (4 mg, 0.008 mmmol) was dissolved in DMSO (0.25 ml). Immediately a CTAB (2 mg, 0.005 mmol) solution in toluene (20 ml) was added under an intensive stirring (Labdancer IKA). After mixing, the obtained mixture is stirred for additional 2 min to accomplish the formation of QDs. The obtained colloidal solution was centrifuged (13500 rpm, 5 min.). The colourless mother solution was decanted from the orange precipitate, which was consequently redispersed in toluene (2 ml) under ultrasound, again centrifugated and proceeded according to the further experimental procedures (nanoparticles can be dried in air or redispersed in toluene). The yield is 3.7 mg.

ClBr-QDs: 1.7 mg of the $(AzrH)PbCl_3$ perovskite (0.0048 mmol) and 1.9 mg $(AzrH)PbBr_3$ (0.0039 mmol) was dissolved in DMSO (0.040 ml). Immediately a CTAB (1.82 mg, 0.0050 mmol) solution in toluene (40 ml) was added under an intensive stirring (Labdancer IKA). After mixing, the obtained mixture is stirred for additional 2 min to accomplish the formation of perovskite. The obtained colloidal solution was centrifuged (13500 rpm, 5 min.). The colourless mother solution was decanted from the yellow precipitate, which was consequently redispersed in toluene (2 ml) under ultrasound, again centrifugated and proceeded according to the further experimental procedures (nanoparticles can be dried in air or redispersed in toluene). The yield is 3.2 mg.

Optical characterization

UV-Vis spectra were recorded on Varian Cary 50 UV-Vis Spectrophotometer in transmission mode in a 1 cm optical path wavelength cuvette. Absorption spectra of QDs colloid in toluene (conc. ca. 1 mg/mL) were recorded in the 440 - 720 nm wavelength range.

Excitation and emission spectra of colloids in toluene (conc. ca. 0.1 mg/mL) were recorded on a fluorescent spectrometer Shimadzu RF-6000. Emission was recorded at 350 nm excitation (for both **Br-QDs** and **ClBr-QDs**) in 400-900 nm range for **Br-QDs** and 400-650 nm for **ClBr-QDs**. Excitation was recorded at 515 nm emission in 200-505 nm range for **Br-QDs** and at 462 nm emission in the 200-450 nm range for **ClBr-QDs**. A 3D spectrum of **Br-QDs** was recorded with a 1 nm and 0.5 nm interval for excitation and emission, respectively, excitation wavelength range 260-440 nm, emission wavelength range 460-580 nm. Photostability measurements of **Br-QDs** were performed with constant illumination at 350 nm, emission was recorded at 515 nm each 10 s for 12810 s.

Physical characterizations

TEM images were acquired using a transmission electron microscope HITACHI - HT7700. PXRD patterns were recorded using a Benchtop Rigaku Miniflex 600 diffractometer. IR spectra were recorded using a Perkin Elmer spectrometer BX II in ATR mode.

Quantum Yield (QY)

Quinine sulphate was taken as a reference with the quantum yield of 57.7%.[2] QY was calculate according to the formula:

$$Q_x = Q_s \cdot \frac{E_x}{A_x} \cdot \frac{A_s}{E_s} \cdot \frac{n_x^2}{n_s^2} \quad (1)$$

where *Q* is the quantum yield, *E* is the integrated emission intensity, *n* is the refractive index of a solvent, A is absorption ("*s*" stands for the standard and "*x*" stands for the sample).
QY for the QD was determined to be 13.7%.

Table S1. Data on the reference and QDs solution used to calculate the QY.

Sample	E (a.u)	A	n
Quinine sulphate	1696250	0.067	1.33[3]
QDs	481035	0.08	1.49[4]

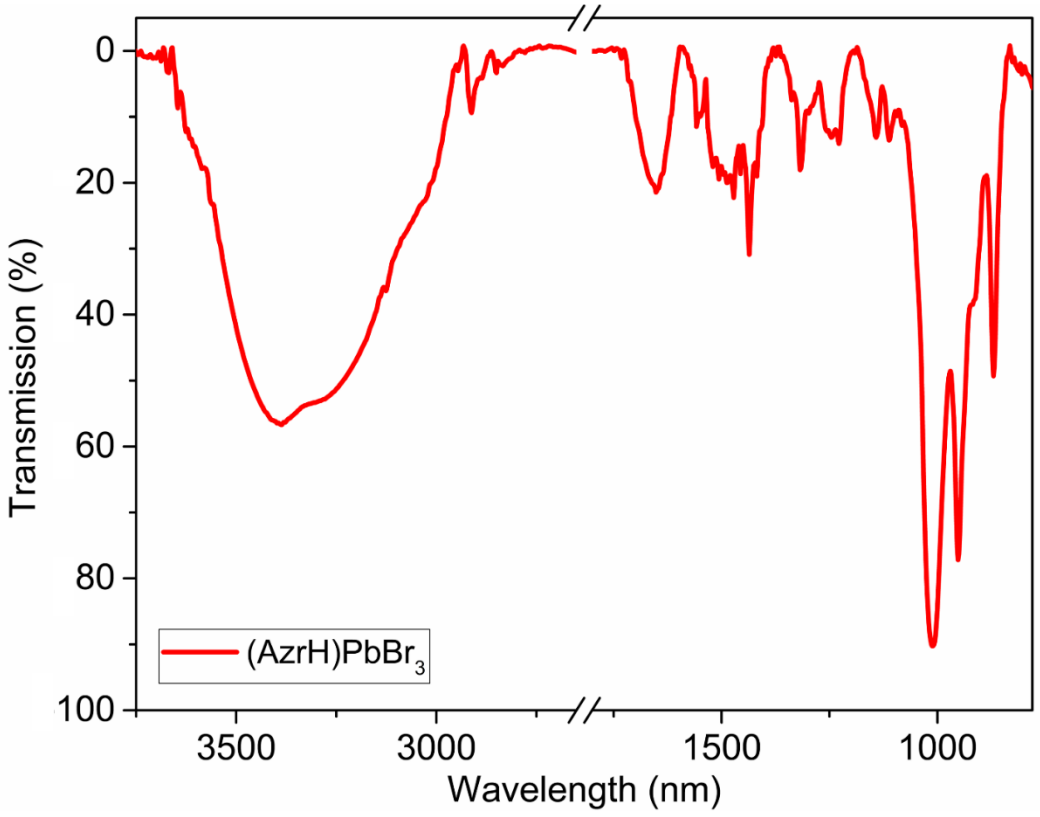

Figure S1. IR spectrum of the QDs recorded in the ATR mode.

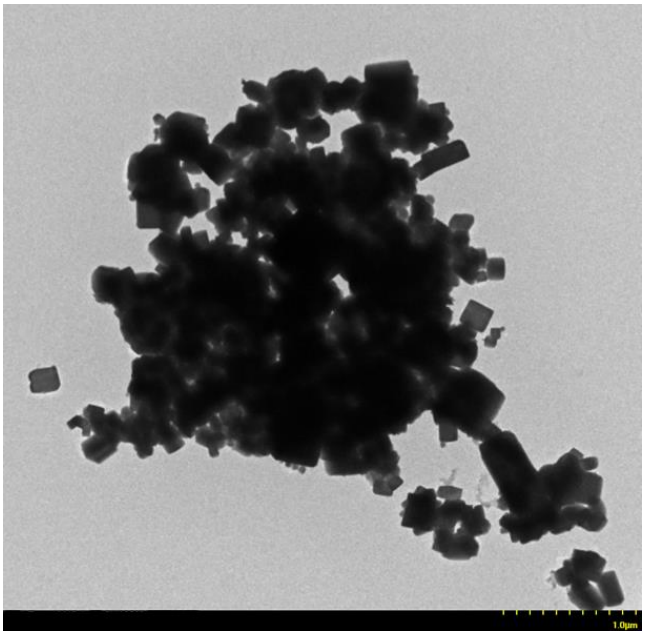

Figure S2. TEM image of (AzrH)$PbBr_3$ obtained in the same conditions as **Br-QDs** but without CTAB addition showing the formation of 0.2-0.8 μm submicronic crystals.

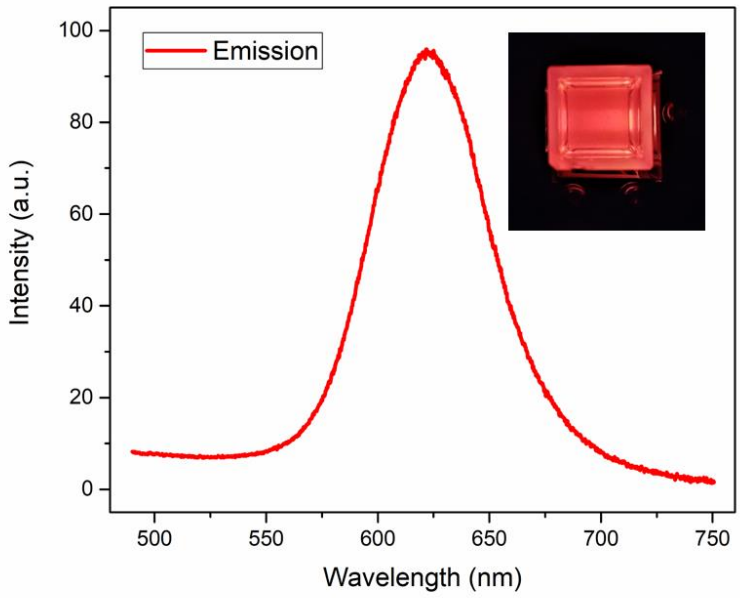

Figure S3. Emission spectrum of the iodine doped QDs (AzrH)$PbBr_{3-x}I_x$ (x is estimated as 1.5 from the precursors ratio) in toluene. Excitation wavelength is 350 nm. Insert: photographs of the colloid under UV excitation.

References

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