Electronic Supplementary Material (ESI) for Nanoscale.

Electronic Supplementary Information (ESI) for

Polar-solvent-free colloidal synthesis of highly luminescent alkylammonium lead halide perovskite nanocrystals

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I. Materials and Methods

Materials and chemicals. The following chemicals were purchased: 1-octadecene (ODE, Sigma-Aldrich, 90%), oleic acid (OA, Sigma-Aldrich, 90%), oleylamine (OAm, Acros Organics, 80-90%), methylamine (CH_3NH_2, Sigma-Aldrich, 2M solution in tetrahydrofuran, THF), lead bromide ($PbBr_2$, ABCR, 98%), lead iodide (PbI_2, ABCR, 99.999%), toluene (Fischer Scientific, HPLC grade) and hexane (Sigma-Aldrich, ≥95%).

Synthesis of $CH_3NH_3PbI_3$ NCs: ODE (5 mL) and PbI_2 (0.187 mmol; 0.086 g) were loaded into a 25 mL 3-neck round-bottom flask and heated to 120 °C. OAm (0.2 mL for $CH_3NH_3PbI_3$ nanocubes; 0.7 mL for $CH_3NH_3PbI_3$ nanoplatelets; 0.6 mL for $CH_3NH_3PbI_3$ nanowires and 0.5 mL for $CH_3NH_3PbI_3$ quantum dots) and OA (0.8 mL for PbI_2 nanocubes; 0.12 mL for $CH_3NH_3PbI_3$ nanoplatelets; 0.7 mL for $CH_3NH_3PbI_3$ nanowires and 1.5 mL for $CH_3NH_3PbI_3$ quantum dots) were injected into the reaction mixture at 120°C under N_2 flow. Then, the temperature was decreased to 50-60 °C and methylamine solution (170 µL of 2M solution in THF and 0.7 mL of OA; 50 µL OA for nanoplatelets) was rapidly injected. After injection, perovskite NCs were separated by centrifugation for 10 min at 12 krpm. After the centrifugation, the supernatant was discarded and the precipitate was redispersed in toluene or hexane.

	$CH_3NH_3PbI_3$ Nanocubes	**$CH_3NH_3PbI_3$ Nanoplatelets**	**$CH_3NH_3PbI_3$ Nanowires**	**$CH_3NH_3PbI_3$ Quantum dots**
OAm	0.2 mL	0.7 mL	0.6 mL	0.5 mL
OA	0.8 mL	0.12 mL	0.7 mL	1.5 mL
OA + Methylamine	0.7 mL + 170 µL	0.5 mL + 50 µL	0.9 mL + 170 µL	0.2 mL + 170 µL

Synthesis of $CH_3NH_3PbBr_3$ NCs: ODE (5 mL) and $PbBr_2$ (0.187 mmol; 0.069 g) were loaded into a 25 mL 3-neck round-bottom flask and heated to 120 °C. OAm (0.1 mL for $CH_3NH_3PbBr_3$ nanowires and 0.3 mL for $CH_3NH_3PbBr_3$ nanoplatelets) and OA (0.5 mL for $CH_3NH_3PbBr_3$ nanowires and 0.3 mL for $CH_3NH_3PbBr_3$ nanoplatelets) were injected into the reaction mixture at 120°C under N_2 flow. After complete solubilisation of a lead halide salt, an additional 0.3 mL of OA was injected. Then, the temperature was decreased to 50-60 °C and methylamine solution (170 µL of 2M solution in THF and 0.7 mL of OA) was rapidly injected. After injection, perovskite NCs were separated by centrifugation for 10 min at 12 krpm. After the centrifugation, the supernatant was discarded and the precipitate was redispersed in toluene or hexane.

The reaction yield in all presented syntheses is 40-70%, based on the mass of isolated NCs.

II. Characterization

Photoluminescence (PL) and absolute quantum yield (QY) measurements. Fluorolog iHR 320 Horiba Jobin Yvon spectrofluorimeter equipped with a PMT detector was used to acquire steady-state PL spectra from solution. PL QYs were estimated according to standard procedure using appropriate dye molecules for blue, green and red spectral regions (coumarine 343, fluorescein, and cresyl violet), as detailed by Grabole *et al*. (*Analytical Chemistry*, 2009, **81**, 6285-6294). PL lifetime measurements were performed using a time-correlated single photon counting (TCSPC) setup, equipped with SPC-130-EM counting module (Becker & Hickl GmbH) and an IDQ-ID-100-20-ULN avalanche photodiode (Quantique) for recording the decay traces. The emission of the perovskite NCs was excited by BDL-488-SMN laser (Becker & Hickl) with pulse duration of 50 ps and wavelength of 488 nm, CW power equivalent of ~0.5 mW, externally triggered at a 1 MHz repetition rate. PL emission from the samples passed through a long-pass optical filter with an edge at 500 nm in order to reject the excitation laser line.

Absorbance measurements $CH_3NH_3PbBr_3$ NCs in solutions and in films. UV-Vis absorption and reflection spectra of the NC films were collected using a Jasco V670 spectrometer equipped with an integrating sphere.

Amplified spontaneous emission and lasing experiments. Measurements were performed with excitation from a femtosecond laser system consisting of an oscillator (Vitesse 800) and an amplifier (Legend Elite), both from Coherent Inc., with a frequency-doubling external BBO crystal; it yielded 100 fs pulses at 400 nm, with a repetition rate of 1 kHz and pulse energy of up to 4 μJ. The laser beam profile had a TEM_{00} mode with a 1.5 mm FWHM diameter. Laser power was measured by a LabMax-TOP laser energy meter (Coherent Inc.) with a nJ measuring head. The optical emission was recorded by a Princeton Instruments SP 2300i spectrometer, equipped with a Thorlabs LC100/M CCD detector array (0.14 nm spectral resolution). The laser beam intensity profiles were analyzed by a LabMax TOP camera from Coherent Inc.

Powder X-ray diffraction (XRD). XRD patterns were collected with a STOE STADI P powder diffractometer, operating in transmission mode. A germanium monochromator, Cu Kα1 irradiation and Dectris Mythen silicon strip detector were used.

Transmission electron microscopy (TEM). TEM images were recorded using a JEOL JEM-2200FS microscope operated at 200 kV.

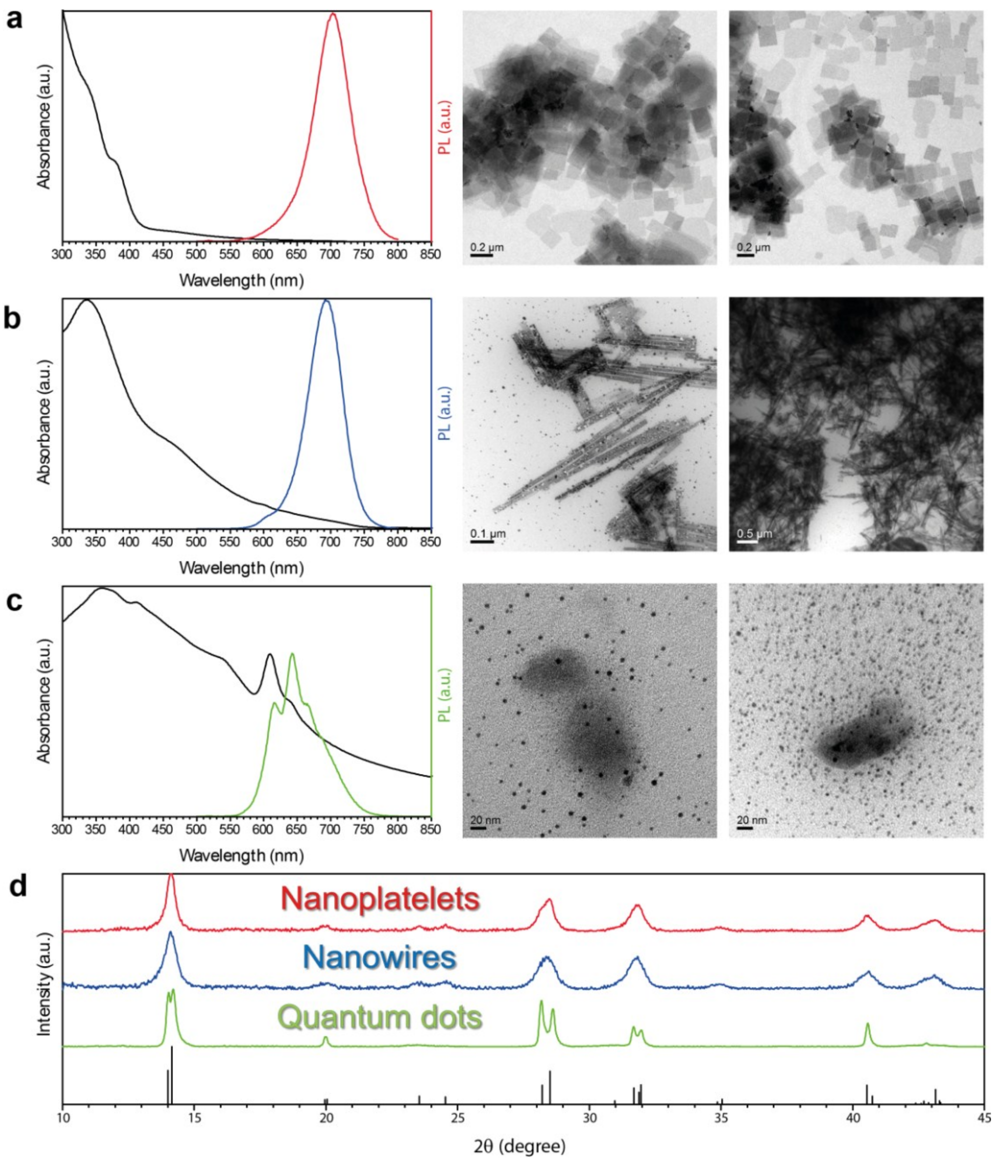

Figure S1. Characterization of $CH_3NH_3PbI_3$ perovskite NCs: normalized optical absorption and PL. spectra along with representative TEM images of (a) nanoplatelets, (b) nanowires and (c) quantum dots; (d) corresponding powder X-Ray diffraction patterns.

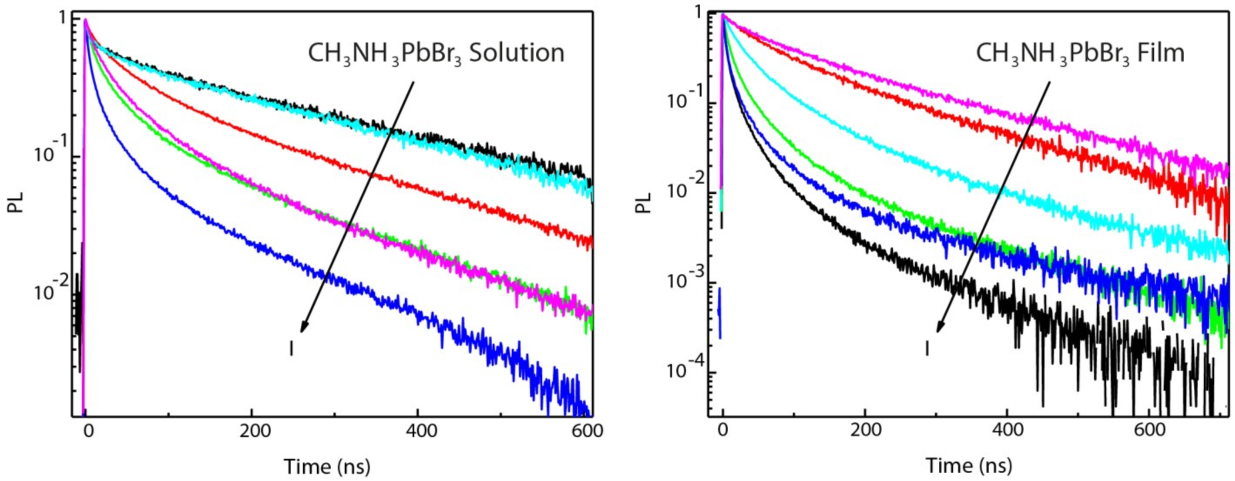

Figure S2. Time-resolved PL decays from the $CH_3NH_3PbBr_3$ nanowires in solution (left) and in thin films on a glass substrate (right). The excitation intensity (I) was varied from 5 to 500 nJ cm^{-2}.