Supporting information for:

Colloidal Cesium Lead Halide Perovskite Nanoplatelets with Monolayer-Level Thickness Control by a Solution Synthesis Approach

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Additional figures:

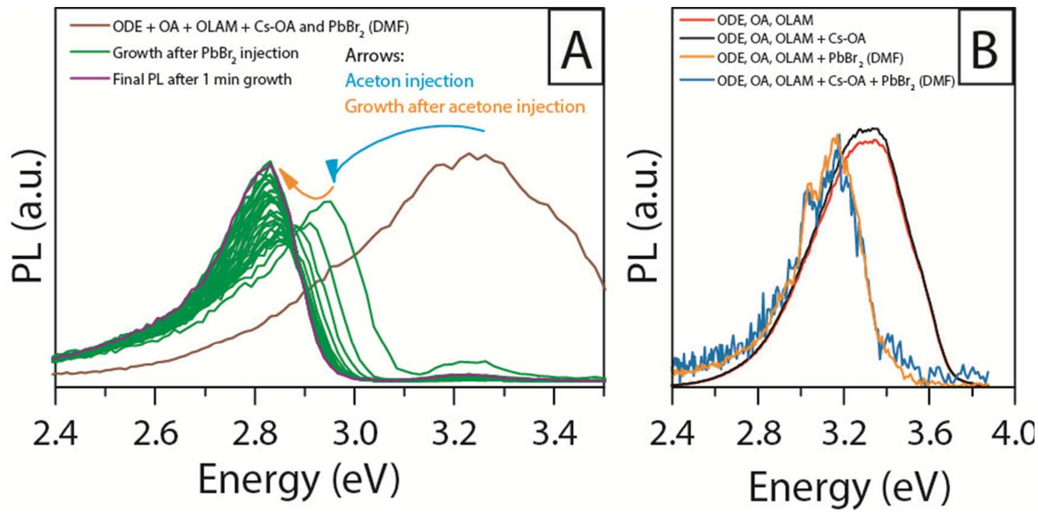

Figure SI1. (A) PL measurement over time during the growth of NPLs. Before acetone injection, the precursor solution was characterized by a broad emission peak centered at approx. 3.2 - 3.3 eV. Immediately after acetone injection, a narrower peak appeared at around 2.95 eV. Within seconds, this peak further red-shifted and narrowed (indicating the nucleation and growth of $CsPbBr_3$ NPLs), and finally settled to an energy value that depended on the amount of HBr added. (B) PL spectra collected on different precursor mixtures, all characterized by a broad emission around 3.2 eV, and with no PL at the energy value seen for $CsPbBr_3$ NPLs.

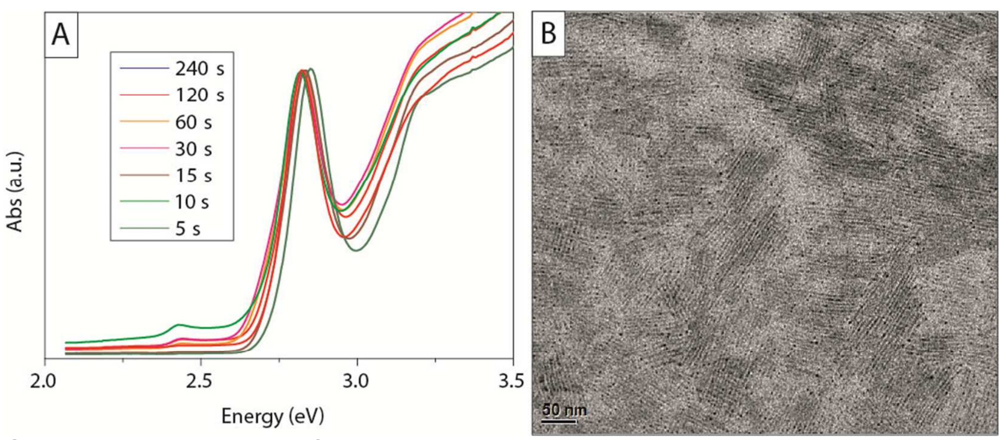

Figure SI2. (A) Absorption spectra of $CsPbBr_3$ NPLs obtained with different times between $PbBr_2$ and acetone injections, in the 5 seconds – 2minutes range. (B) TEM image of NPLs obtained after 240s between the injection of $PbBr_2$ and acetone.

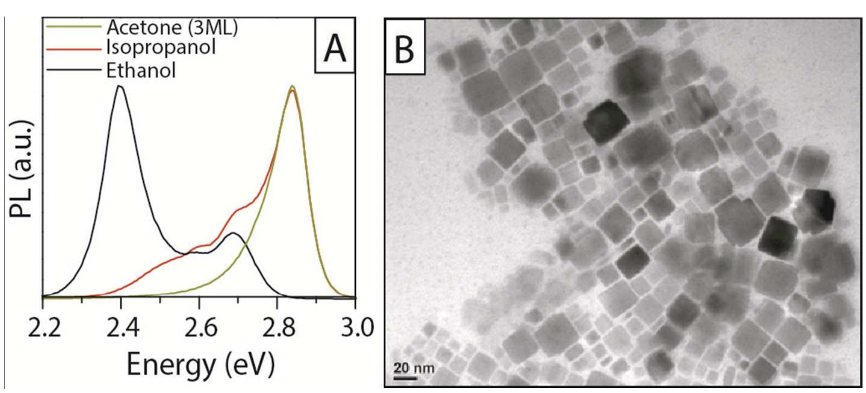

Figure SI3. (A) Comparison of PL spectra collected on $CsPbBr_3$ nanocrystals solutions obtained after using ethanol, isopropanol or acetone as triggers. (B) TEM image of $CsPbBr_3$ NCs obtained with EtOH instead of acetone.

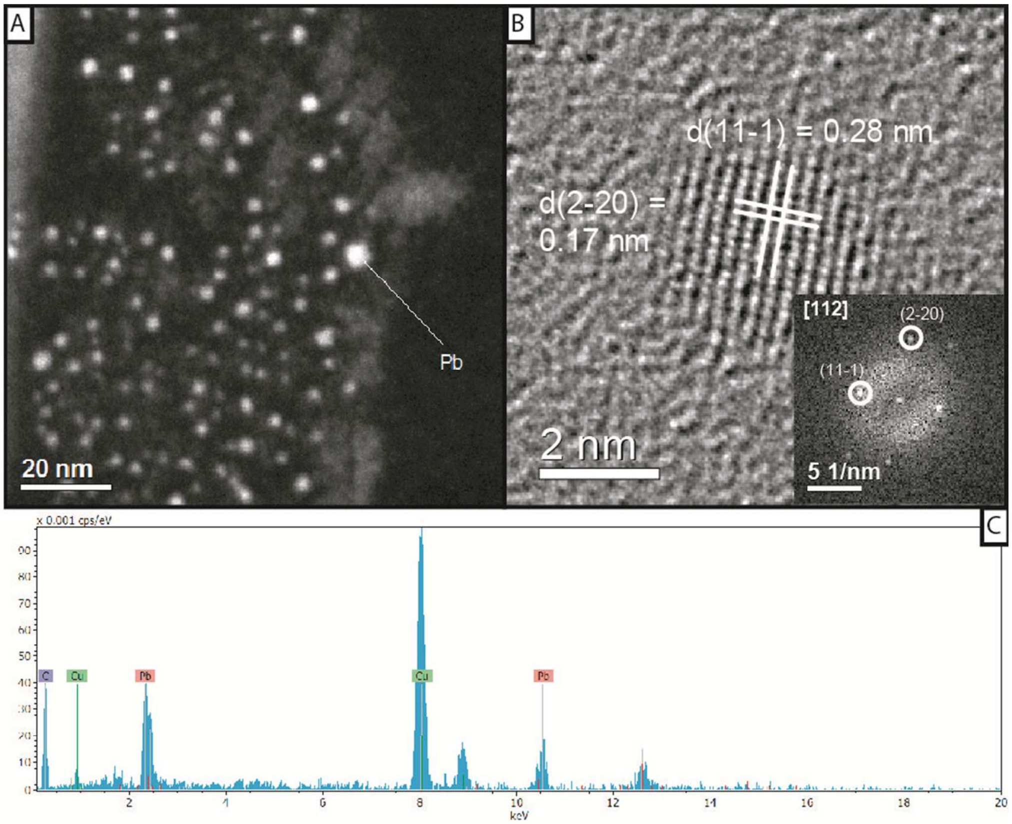

Figure SI4. Analysis of lead NCs formed after e-beam irradiation. (A) Dark-STEM showing high density lead particles. (B) HRTEM of a lead particle, formed after electron irradiation in the TEM, with the lattice parameters compatible with metallic lead. (C) EDS analysis of the particle indicated only the presence of lead (the Cu peaks are from the copper support grid).

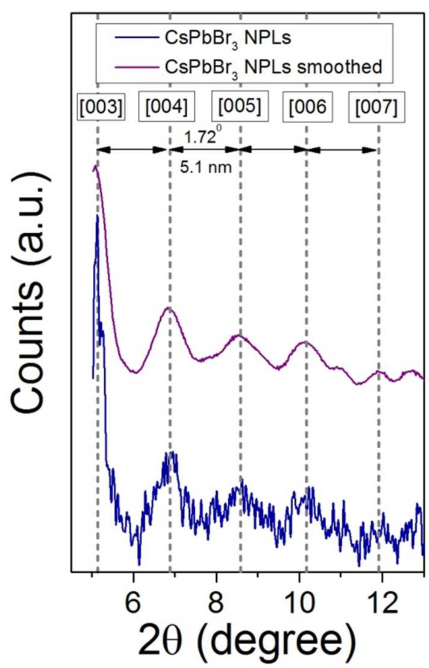

Figure SI5. Low angle XRD showing reflections of stacked NPLs.

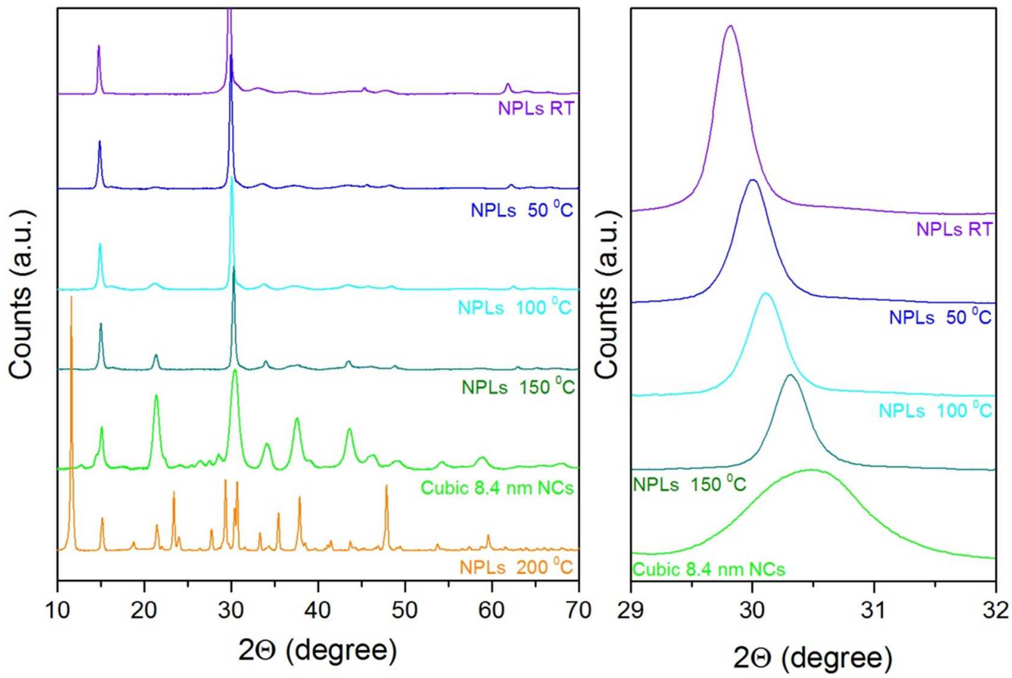

Figure SI6. Evolution of XRD patterns of NPLs with annealing temperature. When going form room temperature (RT) up to 150 °C, the diffraction peaks shifted towards higher 2θ angles, indicating a progressive shrinking of the unit cell. Interestingly, the peak positions after the annealing at 150 °C closely matched with the positions observed for cube-shaped $CsPbBr_3$ NCs (green profile). Annealing to higher temperatures induced a phase change in the material, as shown in the example of the annealing performed at 200 °C (orange pattern).

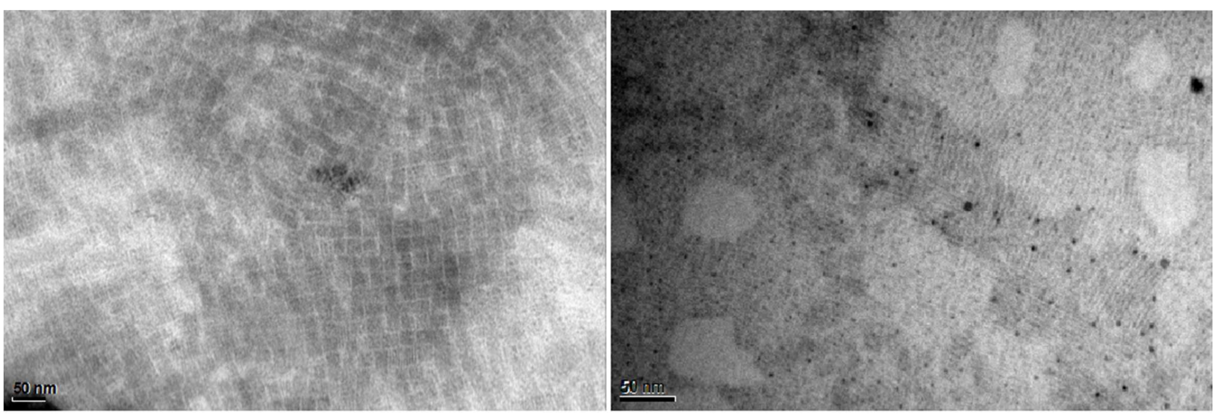

Figure SI7. TEM images of the 4 ML $CsPbBr_3$ NPLs.

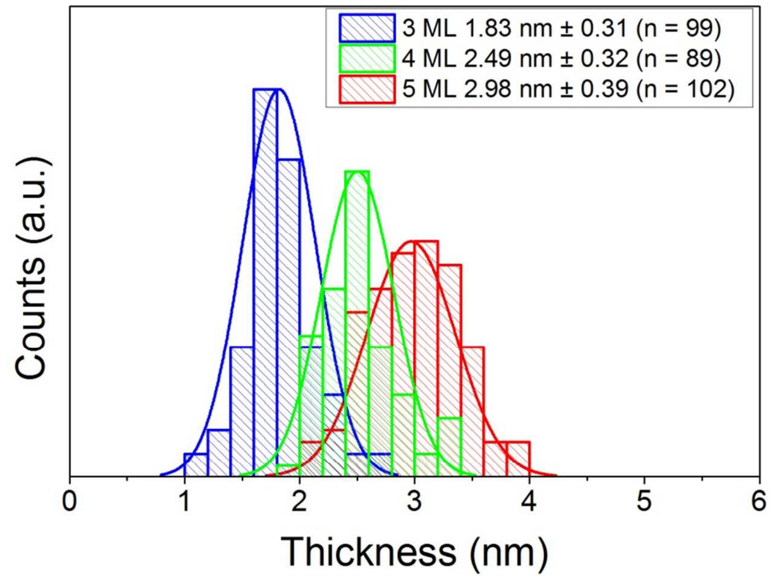

Figure SI8. Thickness distribution of the 3 ML, 4 ML and 5 ML NPLs

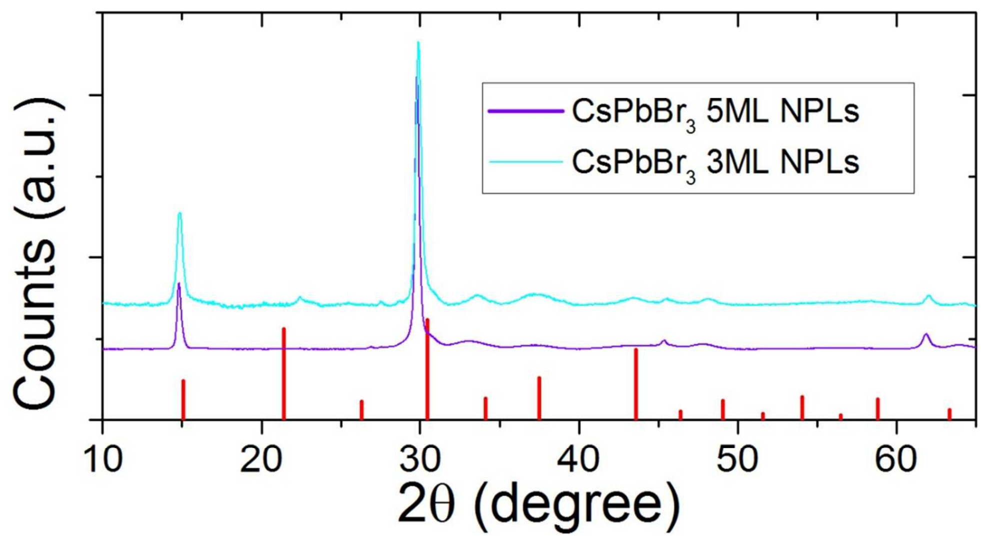

Figure SI9. XRD patterns of 3 ML and 5 ML NPLs.

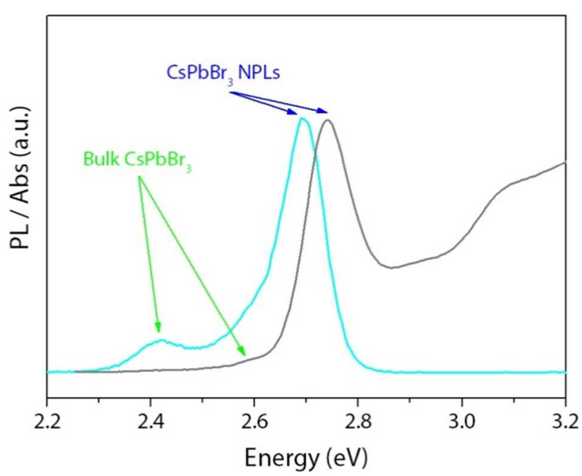

Figure SI10. Partial degradation of the 5 ML NPLs, and formation of bulk $CsPbBr_3$ after 1 week in air.

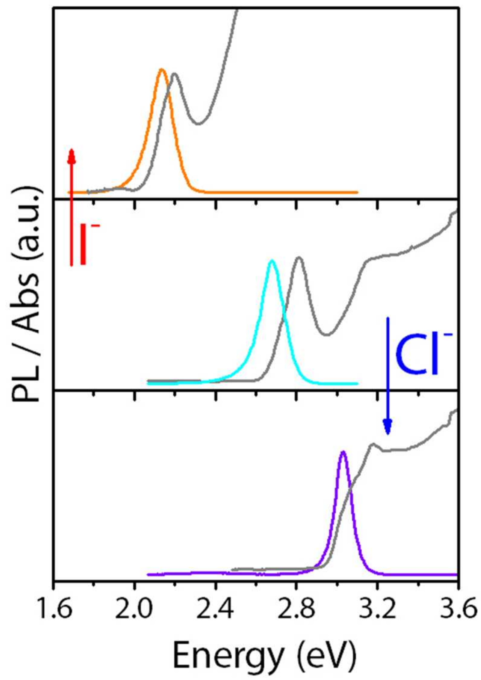

Figure SI11. PL and absorption spectra of the exchanged 5 ML NPLs with Cl^- and I^-.

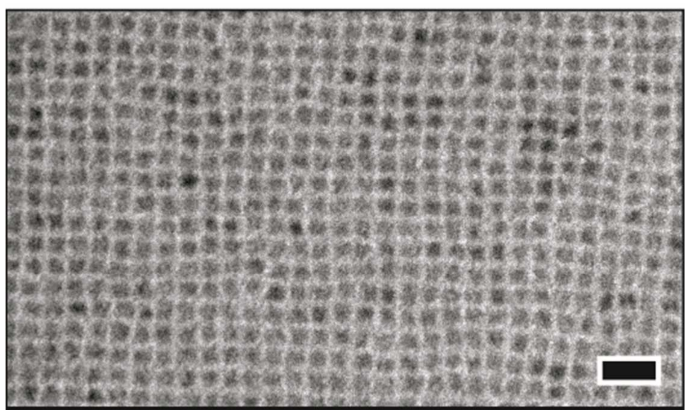

Figure SI12. TEM image of cubic $CsPbBr_3$ NCs. The scale bar corresponds to 50 nm.

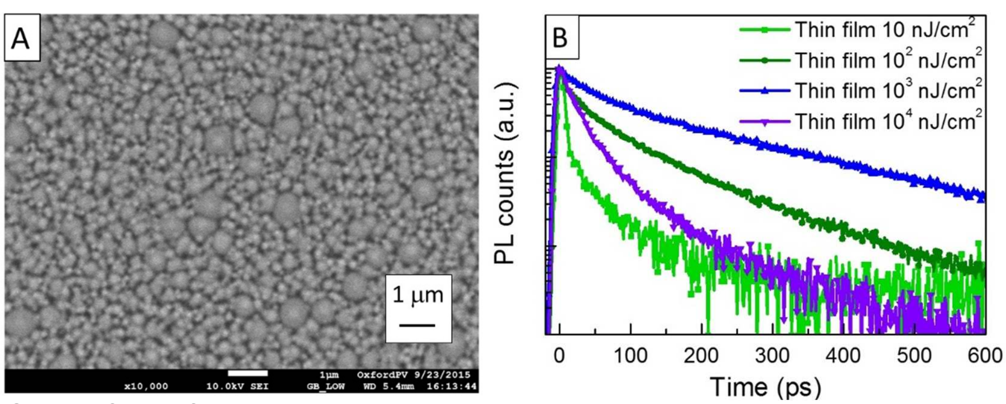

Figure SI13. (A) SEM of $CsPbBr_3$ thin film and (B) intensity dependent PL dynamics.

Note SI1: *For thin films, the excitation density represents average number of photo-generated carriers in unit volume and can be calculated as:*

$$n_p(P_{cw}) = \frac{P_{cw} \cdot \lambda_\gamma}{RR \cdot hc \cdot A_p \cdot d(\lambda_\gamma)}$$

Where P_{cw} is the pump power, λ_γ is the pump wavelength, RR is the repetition rate, A_p is the spot size on sample and $d(\lambda_\gamma)$ is the penetration depth, which can be evaluated as $d(\lambda_\gamma) = d/\alpha(\lambda_\gamma)$, where d is the sample thickness and $\alpha(\lambda_\gamma)$ is the absorbance of the sample at the pump wavelength. In the trPL data presented for CsPbBr3 thin films, the pump wavelength was 480nm, RR=80MHz, the spot size was around 50μm, and the sample optical density was around 0.5. The pump powers varied from 50μW to 40mW, covering a range of excitation densities from 10^{15} to 10^{18} cm^{-3}.

In the case of NC suspension, it is essential to estimate average number of excitations on each NC, rather than the excitations per unit volume. Since the NCs do not show any sign of strong confinement, one can assume that the value of absorptivity (α in cm^{-1}) at 400 nm (corresponding to bulk carrier absorption) is similar to that of the film, which can be evaluated around 10^4 cm^{-1}. One can then estimate the average number of carriers on each nanocrystal as $= \sigma\ \phi_{photon}$, where $\sigma = \alpha\ V^3$(V is the volume of the NC)is the cross-section and ϕ_{photon} is the photon flux. For the range of pump fluences used, we evaluate that the average number of photo-excitations on each NC is much less than one (between 0.01 and 1), a regime that is comparable to the low-excitation regime of the thin films (> 10^{16} cm^{-3}), where there are no strong multi-particle interactions.

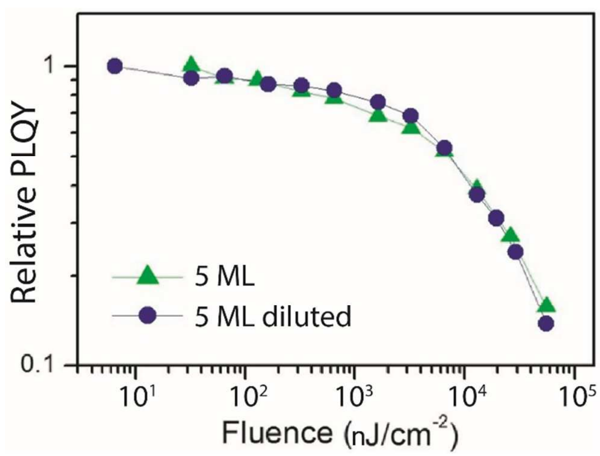

Figure SI14. Relative PLQY of one sample of NPLs before and after a tenfold dilution.

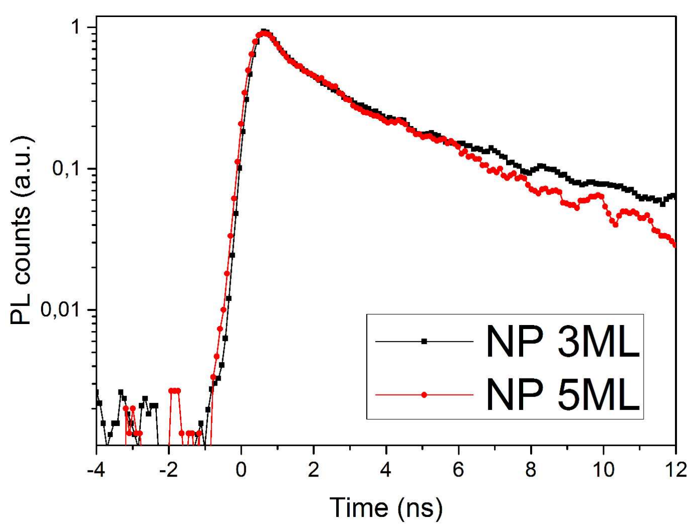

Figure SI15. Comparison of PL dynamics for 3ML and 5ML samples. Pump wavelength for both the experiments was at 400 nm with a fluence of about 100 nJ/cm^{-2}