Supporting Information

of

Photoluminescence Blinking of Single Crystal Methylammonium Lead Iodide Perovskite Nanorods Induced by Surface Traps

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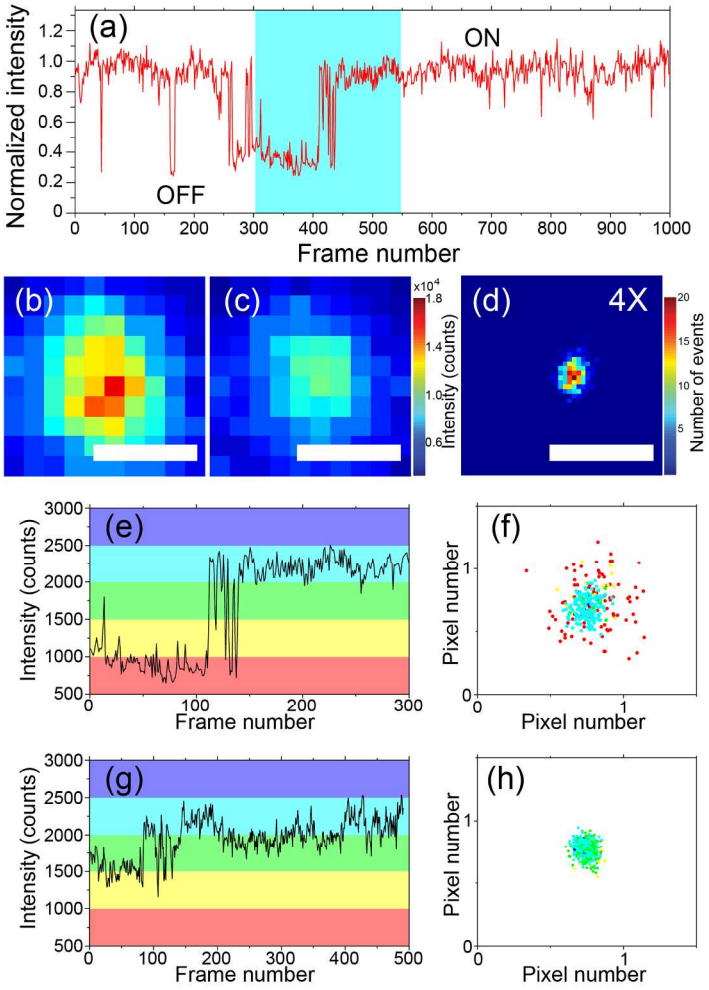

Figure S1. (a) Normalized PL time trace of an individual $MAPbI_3$ nanorod under 10 mW/cm^2 laser illumination. PL blinking between two distinct intensity levels, ON and OFF states, can be observed. (b) PL image of the nanorod of ON state. The scale bar represents 300 nm. (c) PL image of the nanorod of OFF state. The scale bar represents 300 nm. (d) Super-resolution localization histogram map on the blinking nanorod in the time duration highlighted by cyan colour in (a). The scale bar represents 75 nm. Two PL time traces showing blinking and continuous fluctuations are given in (e) and (g) respectively. The corresponding localization results of each frame are plotted in (f) and (h). The colour corresponds to different intensity regions shown in (e) and (g). Variations

in PL intensity did not show apparent changes in fitted emission centre positions with time or any correlation between different PL intensity and localization results.

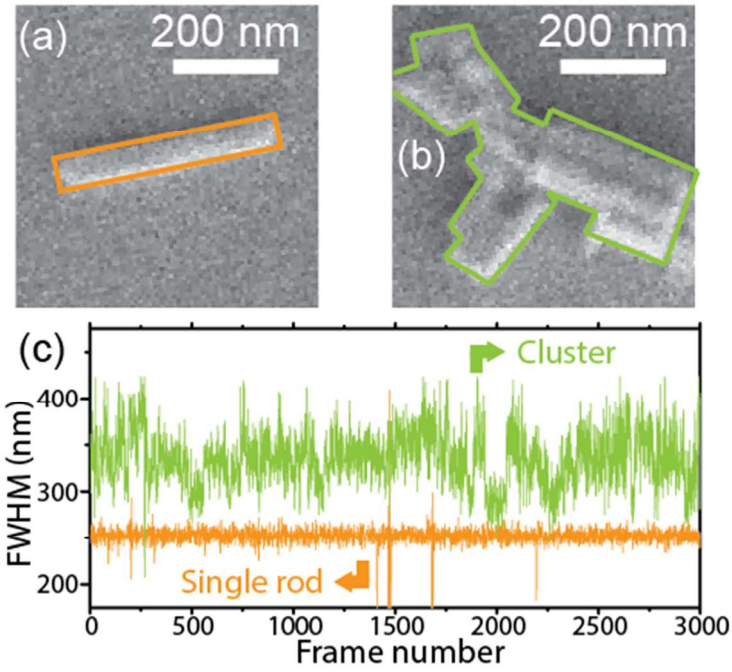

Figure S2. (a) SEM micrograph of an individual $MAPbI_3$ nanorod. The morphology of the nanorod is highlighted by solid orange lines. (b) SEM micrograph of a cluster of nanorods. The morphology is outlined with green solid lines. (c) Time evolution of Gaussian fitting FWHMs of the single nanorod (orange) and the nanorod cluster (green). Localization fitting using a 2D-Gaussian function yielded a constant width of about 250 nm on the single nanorod during the measurement. Spikes on the trace are due to PL blinking OFF states. FWHMs of the nanorod cluster ranging from 280 nm to 420 nm, however, are significantly larger than that of the single nanorod. Moreover, the nanorod cluster showed obvious variations in its FWHM with time during PL blinking, indicating changes in point spread functions of the cluster with time. This observation is due to random blinking of each nanorod of the cluster.

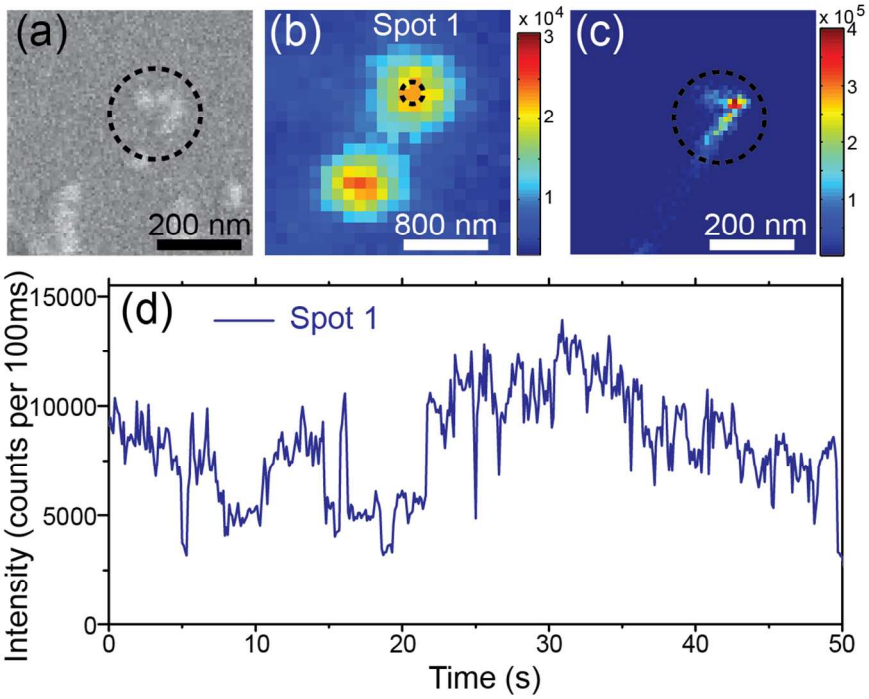

Figure S3. (a) SEM micrograph of perovskite nanocrystals prepared by the conventional thermal annealing method in literature.[1] (b) Two bright spots, highlighted by dashed circles, were observed at the same sample area. The color bar shows PL intensity in the unit of counts per frame (50 ms). (c) Intensity map of super-resolution localization events at the same sample area. The color bar represents the PL intensity at each localization event. (d) PL time traces on the OHP nanostructure.

Figure S3 shows results of the same experiment carried out on $MAPbI_3$ nanostructures prepared by thermal annealing.[1] Island-like deposits can be found on the as-prepared sample. The particles are tens of nanometers in dimension. However, not all OHP particles are visible in PL, showing strong PL heterogeneity from particle to particle as have been reported in literature.[2] SEM micrograph, PL image and super-resolution localization intensity plot of one PL active OHP nanostructure are shown in figure S3a, b

and c respectively. The dashed circles highlight the same structure in figure S3a-c. The nanostructure consists of several grains and yielded multiple PL intensity levels in figure S3d. The localization events on the same sample area in figure S3c closely resemble the morphology of the nanostructure in figure S3a. Note that the color map in figure S3c represent PL intensities in each frame of 50 ms. We can clearly recognize intensity-correlated localization positions in the plot. The observation here closely resembles that in previous report by Tian *et al.*.[1] Therefore, we believe that the previously reported changes in localization positions during PL blinking of single OHP crystals are likely because that multiple emitting crystal grains were present in a diffraction-limited spot.

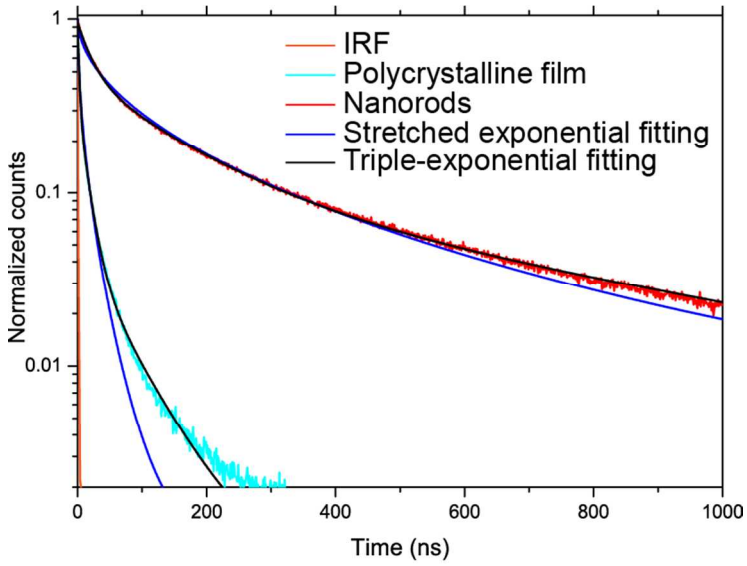

Figure S4. Triple-exponential fitting (black) and stretched-exponential fitting (blue) on the PL decay curves measured on a polycrystalline film (cyan) and single-crystal nanorods (red). The triple-exponential fitting parameters are 22.2 ns (39%), 143.4 ns (51%), and 665.5 ns (10%) for nanorods and 2.2 ns (65%), 13.5 ns (31%), and 65.3 ns (4%) for polycrystalline films. The stretched-exponential fitting parameters are: 64.7 ns

(stretched factor 0.523) for nanorods and 4.38 ns (stretched factor 0.562) for polycrystalline films.

References

1. Tian, Y.; Merdasa, A.; Peter, M.; Abdellah, M.; Zheng, K.; Ponseca, C. S.; Pullerits, T.; Yartsev, A.; Sundström, V.; Scheblykin, I. G. Giant Photoluminescence Blinking of Perovskite Nanocrystals Reveals Single-Trap Control of Luminescence. *Nano Lett.* **2015**, *15*, 1603-1608.
2. de Quilettes, D. W.; Vorpahl, S. M.; Stranks, S. D.; Nagaoka, H.; Eperon, G. E.; Ziffer, M. E.; Snaith, H. J.; Ginger, D. S. Impact of Microstructure on Local Carrier Lifetime in Perovskite Solar Cells. *Science* **2015**, *348*, 683-686.