In-plane stimulated emission of polycrystalline $CH_3NH_3PbBr_3$ perovskite thin films

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Videos

Images of MAPbBr_3 thin films under various excitation intensity

Images of MAPbBr_3 thin films under different excitation polarization

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† Electronic Supplementary Information (ESI) available: graphs and videos to verify spectroscopic properties of different sample.

Additional figures

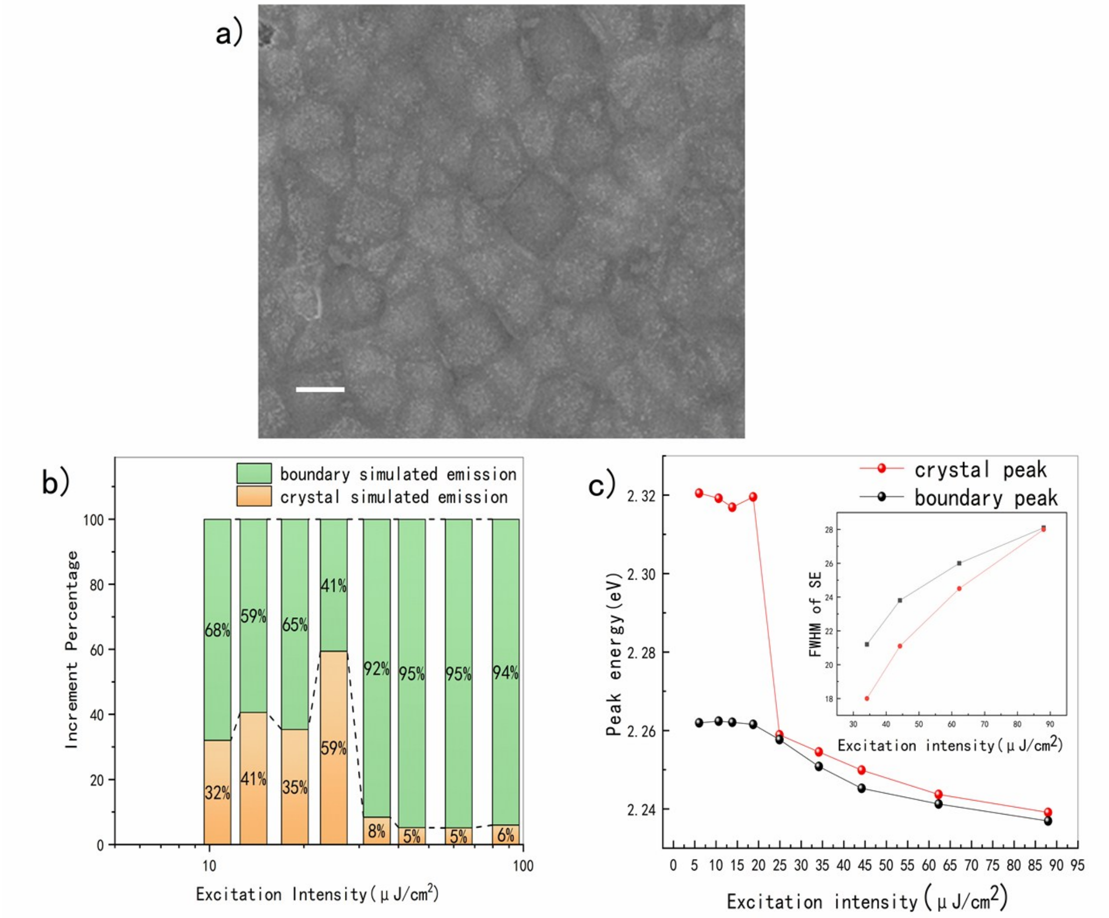

Figure S1. (a) SEM images of $MAPbBr_3$ thin film. Scalebar 10 μm. (b) SE intensity increment at boundaries and inside grains. (c) Peak energy and FWHM of inside grains and boundaries.

SEM image shows the grains in $MAPbBr_3$ thin films averages about 10 μm, and boundaries are quite dim due to the tightly arrangement of grains. We compare the SE increment at boundary (green) and inside (yellow). Considering the luminescent flux reflects the collection of excited particles, the result shows nine tenth of newly added stimulated emission tend to gather and scatter from boundaries when excited above the threshold. Also, SE emissions at boundaries is red-shift and broadened a little in peak energy and FWHM compared with inside of crystal.

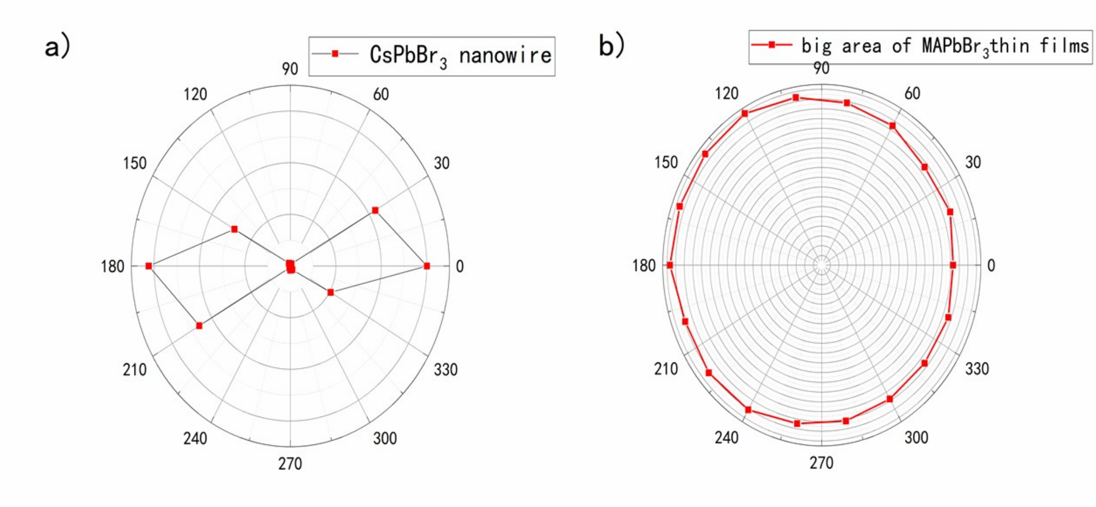

Figure S2. (a) Polarization of a nanowire under 44.2 $\mu J/cm^2$ excitation. (b) Polarization of large area of MAPbBr_3 thin films under 44.2 $\mu J/cm^2$ excitation.

CsPbBr_3 nanowires show a clearly linear polarization under 44.2 $\mu J/cm^2$ excitation, which means its emission will be greatly modulated by the excitation polarization. Using the same system, a large area of 160 μm in MAPb Br_3 thin films shows no polarization, since a large cluster of grains and polycrystalline have no uniform orientation.

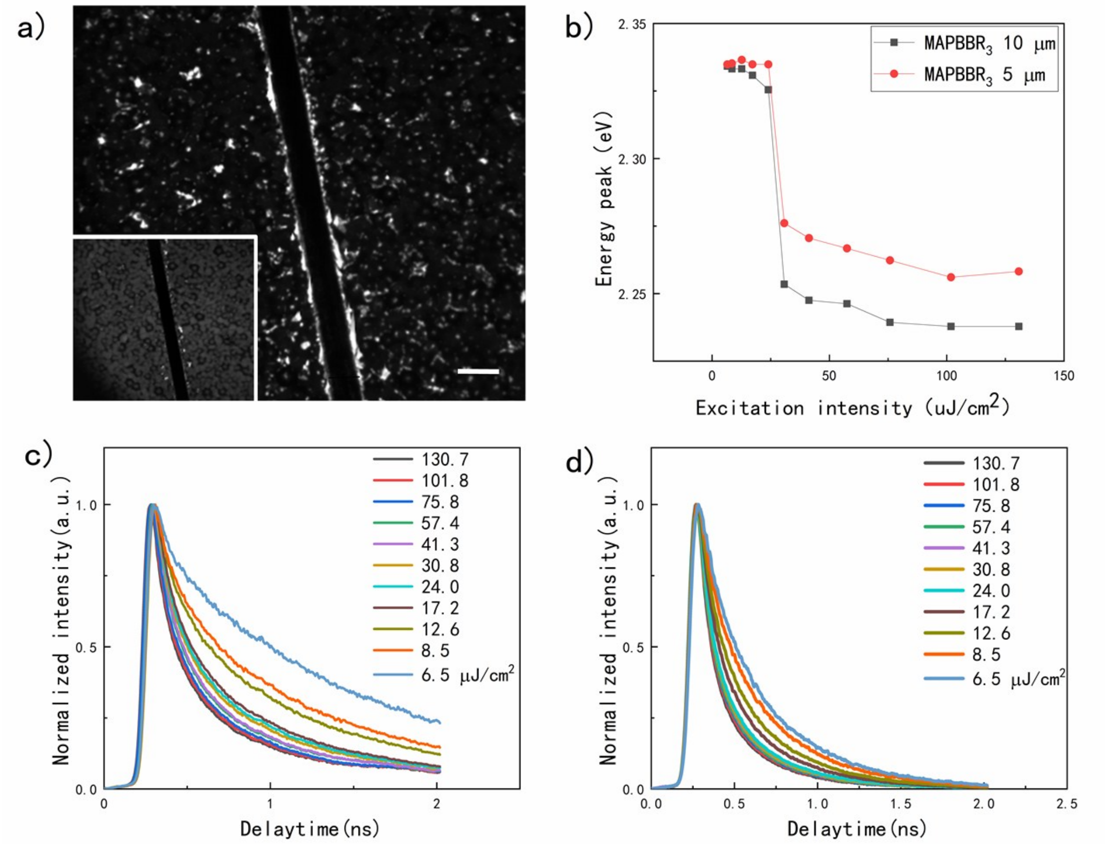

Figure S3. (a) Emission behavior in $MAPbBr_3$ thin films with 5 μm grains. Scalebar 10 μm. (b) Peak energy under various excitation. (c), (d) Fluorescence lifetimes in $MAPbBr_3$ thin films with 10 μm and 5 μm grains.

A shining edge can also be seen in $MAPbBr_3$ thin films with smaller grains (5 μm). but less bright compared to the larger ones. A blue-shifted peak energy and a shortened lifetime of SE are also observed.

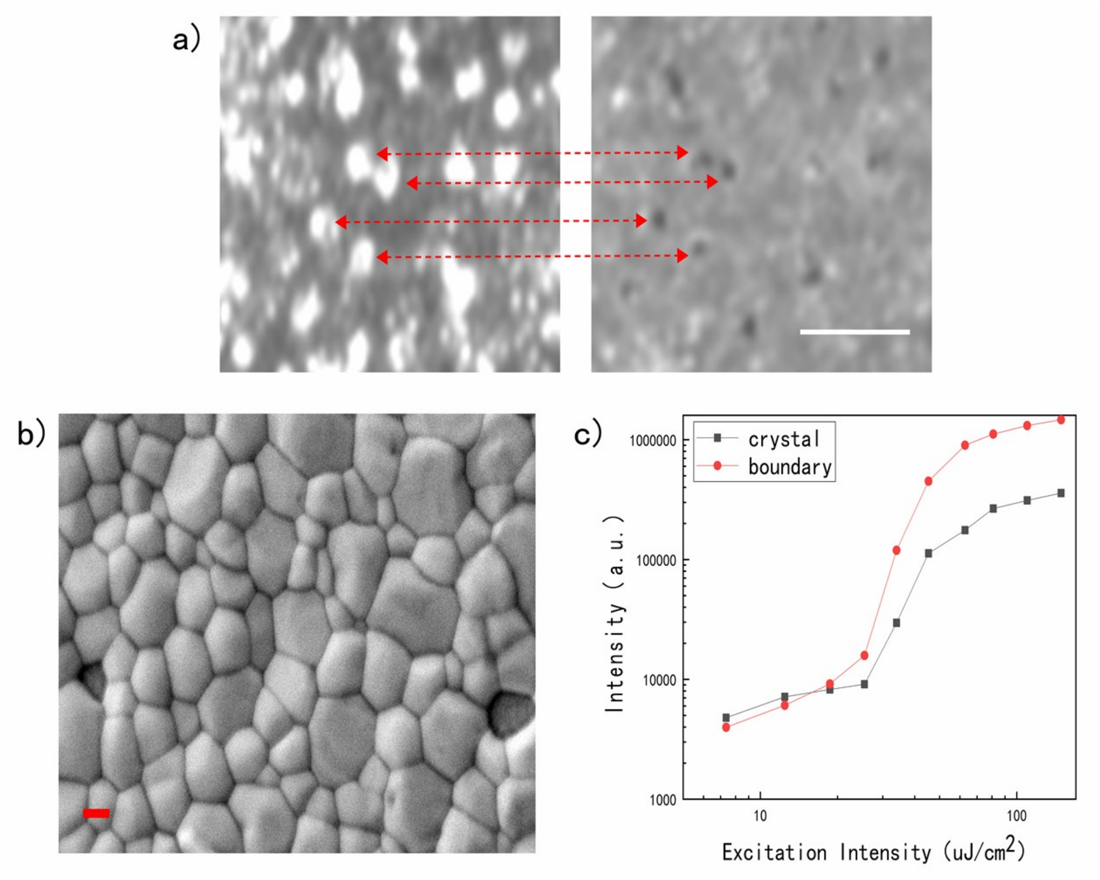

Figure S4. (a) Fluorescence image of FAPbBr_3 thin films under the excitation of 8.09 $\mu J/cm^2$ (left) and 12.4 $\mu J/cm^2$ (right). Scalebar 10 µm. (b) SEM image of FAPbBr_3 thin films. Scalebar 200 nm. (c) Power law relations at the inner part and viods.

Fluorescence below and above threshold SEM images of FAPbBr_3 thin films shows that SE scatter a lot from naturally formed voids and defects. SEM image presents a clear crystalline of 1 µm and below. Power law using the same set-up shows that emission at voids and inside shows a smaller gap, which can be attributed to the absence of effective propagation and amplification of SE.