

## Supporting Information

### **From optical pumping to electrical pumping: the threshold overestimation in metal halide perovskites**

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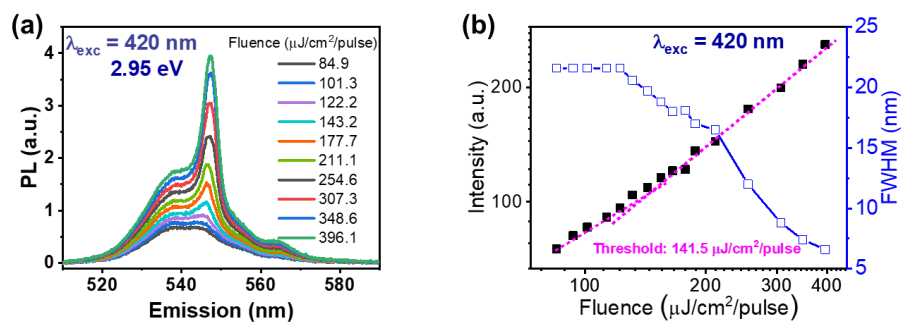
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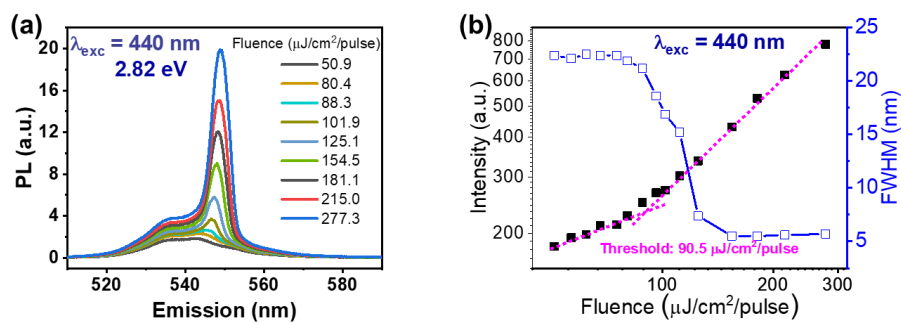
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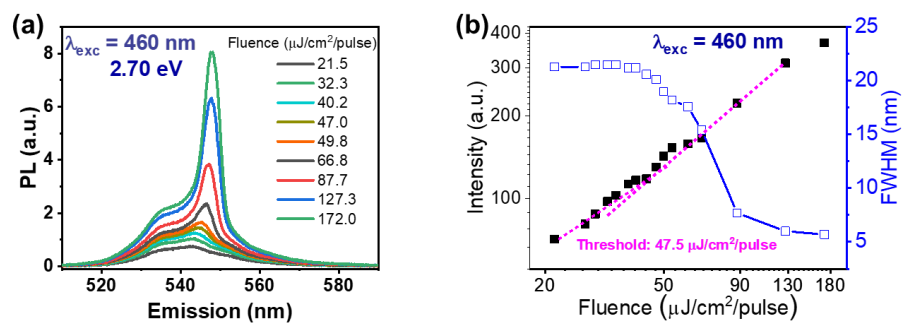
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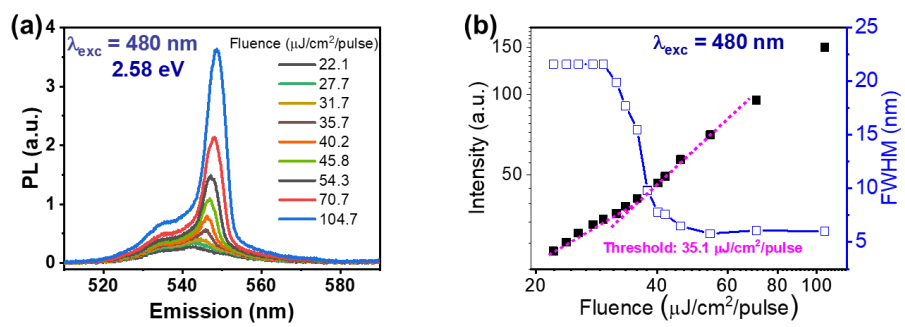
**Fig. S1.** Fluence dependent PL at excitation wavelength of 420 nm. (a) PL spectra and (b) Integrated PL intensity and FWHM at different pump fluences.



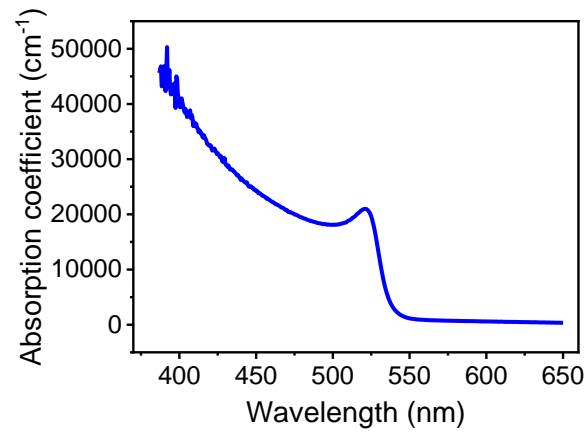
**Fig. S2.** Fluence dependent PL at excitation wavelength of 440 nm. (a) PL spectra and (b) Integrated PL intensity and FWHM at different pump fluences.



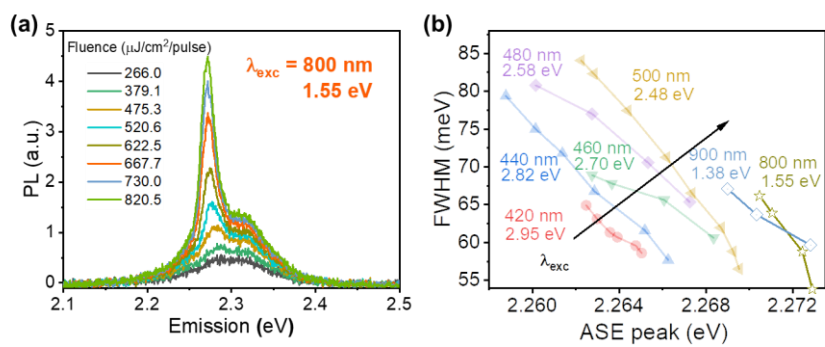
**Fig. S3.** Fluence dependent PL at excitation wavelength of 460 nm. (a) PL spectra and (b) Integrated PL intensity and FWHM at different pump fluences.



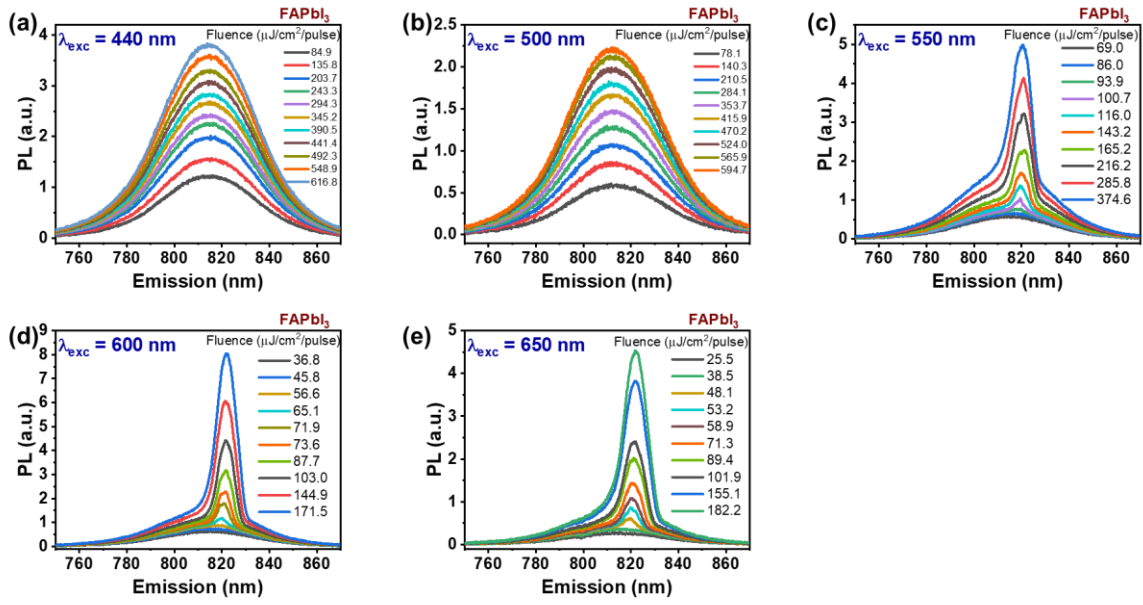
**Fig. S4.** Fluence dependent PL at excitation wavelength of 480 nm. (a) PL spectra and (b) Integrated PL intensity and FWHM at different pump fluences.



**Fig. S5.** Absorption spectrum of the MAPbBr<sub>3</sub> film.

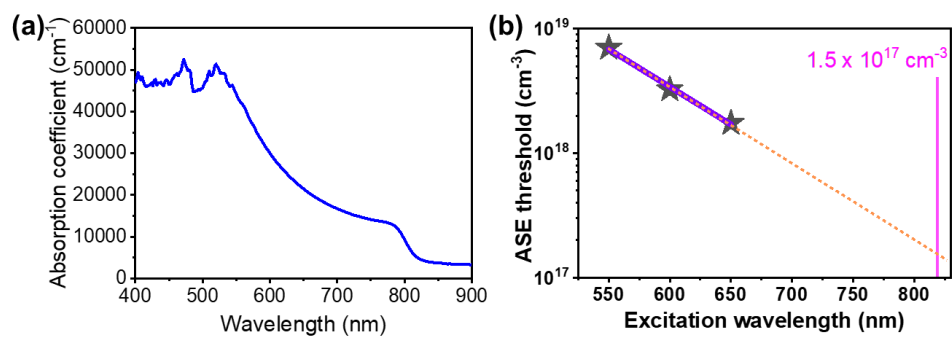


**Fig. S6.** Indication of fast carrier cooling process caused by two-photon up conversion process for MAPbBr<sub>3</sub> film. (a) Fluence dependent PL at excitation wavelength of 800 nm. (b) Comparison of ASE FWHM-ASE peak curves at different excitation photon energies.



**Fig. S7.** Fluence dependent PL at different excitation wavelengths of FAPbI<sub>3</sub> film. (a) 440 nm. (b) 500 nm. (c) 550 nm. (d) 600 nm. (e) 650 nm.





**Fig. S8.** (a) Absorption spectrum of the FAPbI<sub>3</sub> film. (b) Threshold carrier densities at different excitation wavelengths and the extrapolation to the near-to-band-edge photoexcitation wavelength (820 nm).