

# Presence of Maximal Characteristic Time in Photoluminescence Blinking of MAPbI<sub>3</sub> Perovskite

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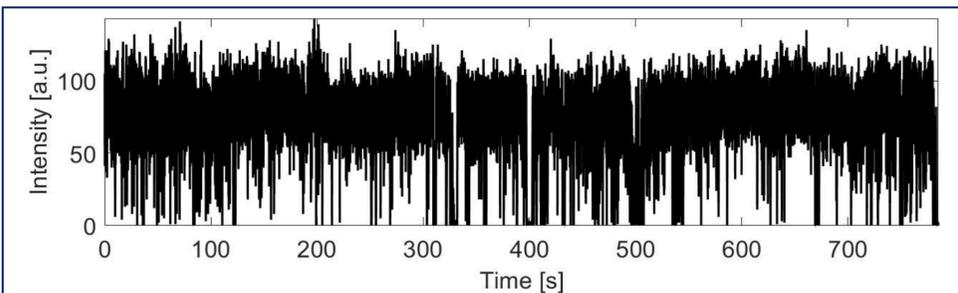
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## Introduction

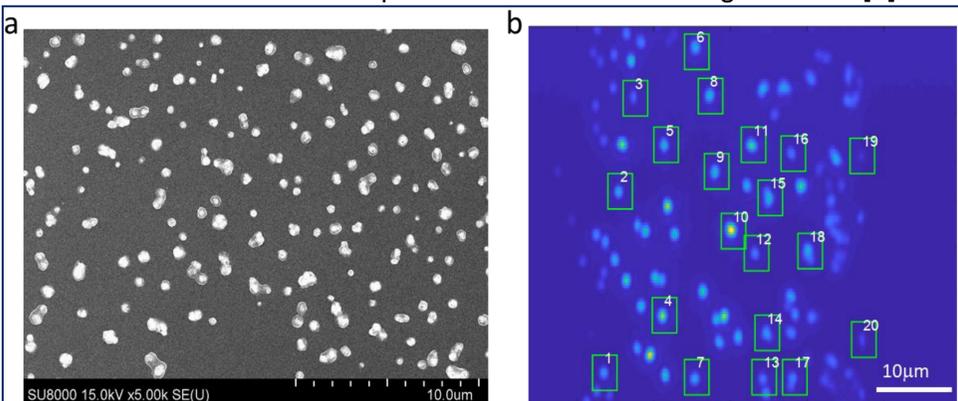
Materials and devices based on crystals with a perovskite structure have received close attention in the last decade. The high efficiency of converting light into electricity (>25%), the ability to create numerous substances with such a structure, and unusual elastic properties make perovskites indispensable in many applications.

Like systems with quantum-confined effects, perovskite microcrystals [1] and films [2] exhibit the phenomenon of long-term changes in luminescence intensity, referred to as blinking. To date, the reason for this behavior in perovskites remains unknown.



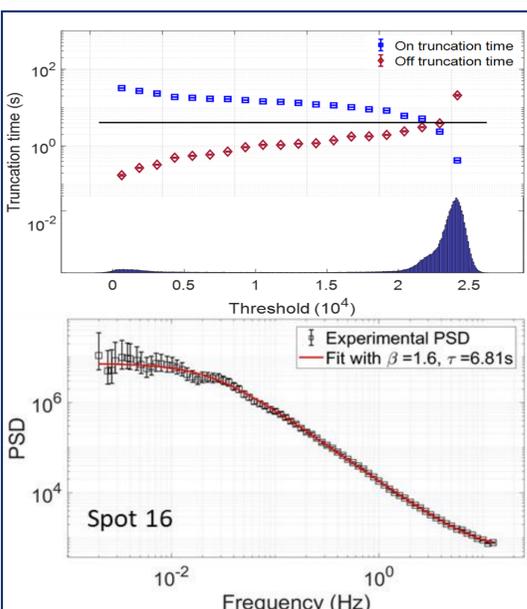
**Fig. 1.** A characteristic view of the materials affected by the blinking phenomenon luminescence intensity trajectory

A detailed description of the PMMA coated MAPbI<sub>3</sub> perovskite microcrystals samples preparation, as well as the detailed description of the luminescent microscope can be found in the original work [1].



**Fig. 2.** (a) SEM and (b) PL images of the studied PMMA coated MAPbI<sub>3</sub> crystals dispersed on a glass substrate. Locations shown on the two images are different.

## Signal processing



**Fig. 3.** (a) Time distribution exponents obtained by fitting with different threshold values (b) PSD of the PL blinking signal fitted by the stretched Lorentzian function

The most popular method of blinking analysis is to calculate the switching times distribution between two states. We used the following function to fit this distribution:

$$S(t) \sim \frac{1}{Ct^\alpha + t^\gamma} \exp\left(-\frac{t}{T}\right)$$

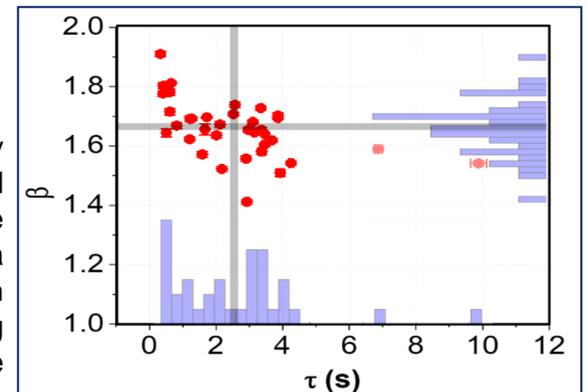
The main disadvantage of this method is the strong dependence of the parameters on the threshold value.

The second approach to the blinking analysis is to construct the process' autocorrelation function, or its Fourier transform – power spectral density (PSD). PSD turns out to obey stretched Lorentzian form:

$$PSD \sim \frac{1}{1 + (2\pi\tau f)^\beta}$$

## Results

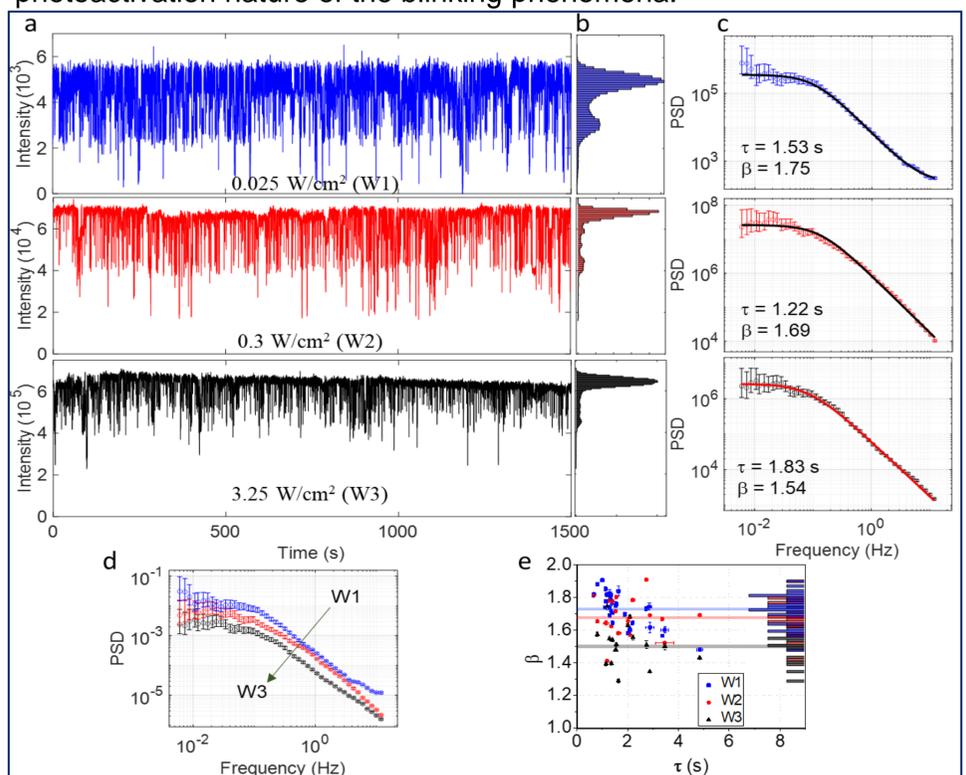
Power spectral density fitting parameters obtained for different crystals are shown in **Fig. 4**. There is a slight correlation between the power law stretching exponent  $\beta$  and the characteristic blinking time  $\tau$ .



**Fig. 4.** Distribution of the stretching exponent  $\beta$  and the characteristic time  $\tau$  extracted from 37 PL intensity traces measured at 0.3 W/cm<sup>2</sup> excitation power.

Power spectral density analysis of very long PL blinking traces of MAPbI<sub>3</sub> sub-micrometer crystals revealed presence of a characteristic timescale in the range of 0.5 - 10 s contrary to the usually observed power law statistics.

Additional experiments were carried out using an excitation laser with different intensities, which differed by an order of magnitude for different experiments. On average, the exponent of stretched Lorentzian decreased with increasing intensity, which indicates the photoactivation nature of the blinking phenomena.



**Fig. 5.** Excitation power dependent PL blinking of MAPbI<sub>3</sub>. (a) PL traces obtained at different excitation powers, (b) corresponding intensity histograms. (c) The corresponding PSDs fitted with the stretched Lorentzian function (d) PSDs obtained from the normalized traces. (e) Statistics of the stretched Lorentzian exponents and characteristic times for 20 crystals.

## References

- [1] S. Seth *et al.*, *Adv. Energy Mater.* 2021, Vol. 11, No. 44.
- [2] X. We *et al.*, *Nano Letters* 2015, Vol. 15, No. 7, pp. 4644-4649.

## Acknowledgments

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