Laser induced photoresponse in perovskite solar cells

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Metal halide perovskites are widely used in optoeletronics devices such as photodetectors, LEDs and perovskite solar cells (PSCs). Rapid progress in the field of PSCs has made it posible to achieve approximately 25% energy conversion efficiency at present time [1]. However, the problems of stability and reproducibility of PSCs parameters have not been fully resolved until now and therefore research on perovskite structures remains relevant.

In this work, we present the results of experimental study of transient photovoltage (TPV) and photoelectric characteristics of the PSCs. The triple cation perovskite layers obtained by one-step deposition method from the precursor solution were used in the formed solar cells (see [2] for the detail). The TPV of the PSCs were measured using of 7 ns laser pulses at a wavelength of 532 nm.

Fig.1 presents the temporal profiles of photovoltage induced across two PSCs smples with diferent concentrations of Cs in perovskite layer.

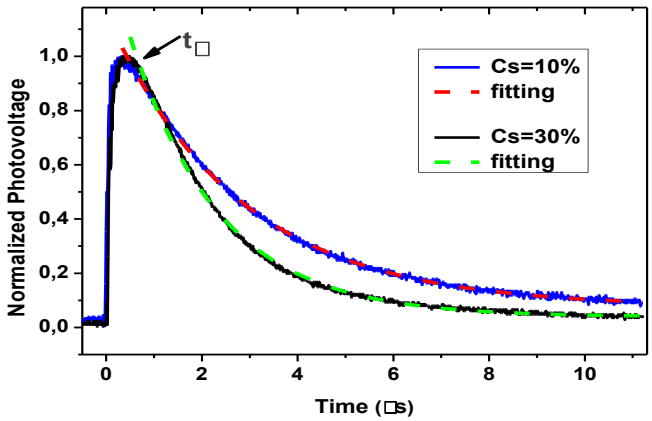

Fig. 1. Photovoltage decay transients of the solar cells with different concentrations of Cs in perovskite layer. Excitation laser power density 1.4 mW/cm^2

The photovoltage curves consist of a fast rising part, which, when reaching the maximum, is followed by a slow decaying part. The photovoltage reaches its maximum value with a delay of approximately 100 to 200 ns after laser excitation. The delay is defined by the time of electron transport in the perovskite layer. It is seen that, in a certain interval of time ($t > t_1$), the decay of the TPV can be approximated as a exponential function $U_{ph} = U_{ph0}\, e^{-t/\tau}$, where U_{ph0} is the value of U_{ph} at time t_1 and τ is the characteristic decay time constant.

Thus, the experimental results obtained in this work show that using the transient photovoltage method, it is possible to study the parameters of perovskite solar cells.

[1] E. H. Junget al., Nature 2019, 567, 511.
[2] S. Ašmontas, et al., Materials 2022, 15, 1936