7

Transient absorption spectroscopy in the research of ion segregation in perovskites

Jacek J. Baranowski, Mykhailo Solovan, Sanjay Sahare, Marcin Ziółek
Adam Mickiewicz University, Poznań, Poland

Abstract

Light-induced ion segregation is an interesting phenomenon taking place in mixed-halide perovskites. Although it is one of the effects seriously limiting the performance and photostability of perovskite solar cells (PSCs), its mechanism is still under debate. In our recently published research, we employed ultrafast transient absorption (TA) spectroscopy to explore the dependency of segregation speed and extent on factors such as pulse energy, type of illumination, and excitation wavelength. Here, we also present the results of our latest extensive studies on the importance of perovskite-charge transport layer interface type. We studied fully operational triple-cation PSCs, a composition in which ion segregation had not been observed with TA before. We proved that the counterintuitive inhibition of ion segregation taking place under high irradiance, which had been previously rationalized using rather sophisticated models, can be explained by the local temperature increase under higher pulse fluences. We also found that the segregation in this composition is substantially more profound under pulsed illumination than under continuous one. The presence of any charge transport layer (such as TiO_2 or spiro-OMeTAD) is crucial for the process to happen, an observation which supports the electric field-based ion segregation model. The phenomenon is the fastest in the vicinity of mesoporous TiO_2, which might be contributed to the enhancement of the electric field inside the porous layer. Additionally, under the strongest investigated light intensities for which the local heating significantly suppress ion segregation, we observed the propagation of coherent longitudinal acoustic phonons.