超快激光光谱探测钙钛矿的电荷载流子转移

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近年来，尽管有机-无机卤化铅钙钛矿在能量转换应用方面引起了巨大的科学关注，但钙钛矿光伏器件中温度和空穴传输层 (HTL) 类型对电荷载流子动力学和复合过程的影响仍在很大程度上未被探究。

基于上述问题，希腊研究与技术基金会电子结构与激光研究所 (IESL) Emmanuel Stratakis 教授团队对有机-无机钙钛矿晶相的电荷载流子动力学变化进行了深入研究。在低于室温的温度下，比较玻璃/钙钛矿结构 (参考) 和两种不同的玻璃/ITO/HTL/钙钛矿构型的微光致发光 (μPL) 和超快时间分辨瞬态吸收光谱 (TAS) 的结果。该工作的目的是探索和揭示不同钙钛矿晶相的电荷载流子动力学，同时也考虑所使用的空穴传输层聚合物的影响。先在玻璃、PEDOT:PSS 和 PTAA 聚合物上分别沉积 $CH_3NH_3PbI_3$ (钙钛矿) 薄膜，并在 85 K 至 215 K 的温度范围内研究所制备的玻璃/$CH_3NH_3PbI_3$ 和玻璃/ITO/HTL/ $CH_3NH_3PbI_3$ 结构，以探索 $CH_3NH_3PbI_3$ 斜方和四方晶相的电荷提取动力学。研究表明，低温下的载流子动力学不仅受空穴传输层的影响，还与不同钙钛矿的晶相密切相关。

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Probing the crucial charge carrier transfer processes and dynamics within perovskite active layers by means of time-resolved ultrafast laser spectroscopy

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Despite that organic-inorganic lead halide perovskites have attracted enormous scientific attention for energy conversion applications over the recent years, the influence of temperature and the type of the employed hole transport layer (HTL) on the charge carrier dynamics and recombination processes in perovskite photovoltaic devices is still largely unexplored. In particular, significant knowledge is missing on how these crucial parameters for radiative and non-radiative recombinations, as well as for efficient charge extraction vary among different perovskite crystalline phases that are induced by temperature variation.

The Ultrafast Laser Micro- and Nano- processing group (ULMNP) of IESL described micro photoluminescence (μPL) and ultrafast time resolved transient absorption spectroscopy (TAS) results in a reference Glass/Perovskite architecture and two different Glass/ITO/HTL/Perovskite configurations at temperatures below room temperature. The objective of this work is to probe and shed light on the charge carrier dynamics of different perovskite crystalline phases, while considering also the effect of the employed hole transport layer (HTL) polymer. Namely, $CH_3NH_3PbI_3$ films were deposited on Glass, PEDOT:PSS and PTAA polymers, and the developed Glass/$CH_3NH_3PbI_3$ and Glass/ITO/HTL/$CH_3NH_3PbI_3$ architectures were studied from 85 up to 215 K in order to explore the charge extraction dynamics of the $CH_3NH_3PbI_3$ orthorhombic and tetragonal crystalline phases. Interestingly enough, the article reports evidence that the charge carrier dynamics at low temperatures, are not only affected by the employed hole transport layer, but in addition are strongly correlated to the different perovskite crystal phases.

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