The impact of nanoscale landscape in the performance of halide perovskites

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Halide perovskites are generating enormous excitement for their use in high-performance yet inexpensive optoelectronic applications. Nevertheless, these solution processed materials have a plethora of micro- and nano-scale heterogeneities and their impact on performance and stability need to be understood.

In this presentation, I will briefly introduce our latest results on the development of perovskite based solar cells, LEDs, photodetectors and high energy radiation detectors. I will show how in all cases the presence of nanoscopic heterogeneities dictates how the ultimate device performs. We have developed a multimodal microscopy suit to determine the relationship between material structure, chemistry and photophysical properties on the nanoscale using advanced microscopy techniques. I will show how synchrotron nanoprobe and optical spectroscopic methods correlated at the nanoscale explain why halide perovskites are remarkably tolerant to defects. These observations reflect that the quest of highly pristineness in traditional semiconductors is not necessarily a condition for low temperature, solution processed halide perovskites to perform well when integrated into devices. Further, I will discuss how measuring photoluminescence as a function of voltage allows us to extract pseudo-JV curves and device performance metrics with sub-micron spatial resolution. Spatially correlating these measurements with synchrotron nanoprobe X-ray fluorescence, we decouple how different device architectures influence nanoscale degradation. We will comment on the implications these findings have for microscopically improving device stability.