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(G) Photovoltaic mobility imaging from near-field charge extraction by linearly increasing voltage

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Understanding of the effect of active layer morphology on the operation of photovoltaics is crucial to the development of higher efficiency devices. A particular parameter with a complex dependence on local environment is the mobility of photogenerated charge carriers, upon which carrier extraction is highly dependent, and therefore overall device performance. Bulk device photo-carrier mobility is available through several single-point measurements, and cross-sectional mobility mapping with sub-micron scale resolution is achievable on moderately thin film devices. However, nano-scale resolution lateral imaging of intrinsic optoelectronic properties has only extended as far as surface photovoltage based measurements, which garner recombination information, and are speculative on carrier dynamics. Here, we present a novel integration of scanning near-field optical microscopy (SNOM) with charge extraction by linearly increasing voltage (CELIV) for direct mobility mapping, acquired in conjunction with atomic force microscopy (AFM) topography scans. By utilizing near-field illumination and nano-probe charge extraction via a conducting cantilever, our technique is both photonically and electronically localized, offering improved resolution and eliminating incidental measurement of delocalized material properties. This technique allows for measurements on a range of photoactive samples, as measurements on exposed active layer surfaces of PN homojunctions allows for investigation of morphological influence on free charge extraction, and measurements on bulk heterojunction samples allows for correlation of charge extraction to phase interface morphology. Freedom to change extraction voltage polarity and DC offset allows for variability in probed carrier type and device operation mode. This helps us achieve a versatile method for direct measurement of photogenerated charge dynamics in photovoltaic devices with nano-scale resolution.

Keyword-1

Near-field optics

Keyword-2

Solar cells

Keyword-3

Nano-optics

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