Investigation of ZnO/PbS Nanocrystal Interfaces for Photonic Device Applications

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Research into lead sulfide (PbS) nanocrystal devices has garnered much attention recently due to their notable performance as photovoltaic devices and short wave infrared photodetectors, among other applications.[1,2] Common within such devices is the use of metal oxide thin-films (e.g., ZnO, ITO, NiO, etc.) that act as charge-selective contacts. Therefore, characterization of the interfacial properties between metal oxides and PbS nanocrystals is crucial to the overall development of these technologies. In this contribution, we present our investigations into the properties that dominate operational efficiency of the ZnO/PbS heterojunction. Through a series of varying oxide pre-treatments (e.g., plasma cleaning, small-molecule surface modifications, and wet-chemical etching), we investigate how the state of the surface affects band-edge offsets (via Ultraviolet Photoemission Spectroscopy), changes in the surface chemistry at the interface (through X-ray Photoemission Spectroscopy), and overall structural changes (utilizing Scanning Probe Microscopy). Additionally, we provide insight into how these pre-treatments affect overall device performance in the standard inverted device geometry.

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[2] R. J. Curry, Nat. Photonics **10**, 81(2016).