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Ultrafast spectroscopy of CuInSeS colloidal quantum dots: Auger recombination, carrier multiplication, and electron transfer NIKOLAY MAKAROV, HUNTER MCDANIEL, ISTVAN ROBEL, VICTOR KLIMOV, Los Alamos Natl Lab — We perform systematic transient absorption and time-resolved photoluminescence measurements on $CuInSe_xS_{2-x}$ quantum dots (QDs), with sizes of 3-5 nm, that have recently been utilized in sensitized solar cells achieving certified efficiencies above 5%. We study QD volume and composition dependence of various excited charge carrier processes, including biexciton Auger recombination, carrier multiplication (CM), and electron transfer (ET) to TiO_2. Biexciton decay is similar to that of CdSe QDs of the same volume, which supports the previously reported generality of Auger lifetimes in QDs. CM quantum yields approach 20% indicating that this material could enable photovoltaic efficiencies exceeding the Shockley-Queisser limit. Size-dependent ET (20-40 ns) is fairly slow, which highlights the need for efficient suppression of competing nonradiative processes that can be associated, for example, with the surfaces of poorly passivated QDs. We also demonstrate the importance of having a redox electrolyte (used in sensitized solar cells for hole extraction) present during ET studies in order to prevent charge build-up. Our measurements are critical for understanding the photophysical properties of this new material, and they also suggest general pathways towards improving QD solar cells.

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