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Ultrafast Single and Multiexciton Energy Transfer in Semiconductor Nanoplatelets[1]

RICHARD SCHALLER, Argonne National Laboratory Northwestern University

Photophysical processes such as fluorescence resonance energy transfer (FRET) enable optical antennas, wavelength down-conversion in light-emitting diodes (LEDs), and optical bio-sensing schemes. The rate and efficiency of this donor to acceptor transfer of excitation between chromophores dictates the utility of FRET and can unlock new device operation motifs including quantum-funnel solar cells and reduced gain thresholds. However, the fastest reported FRET time constants involving spherical quantum dots (QDs) (0.12-1 ns), do not outpace biexciton Auger recombination (0.01-0.1 ns), which impedes multiexciton-driven applications including electrically-pumped lasers and carrier-multiplication-enhanced photovoltaics. Precisely controlled, few-monolayer thick semiconductor nano-platelets with tens-of-nanometer diameters exhibit intense optical transitions and hundreds-of-picosecond Auger recombination, but heretofore lack FRET characterizations. We examine binary CdSe NPL solids and show that inter-plate FRET (˜6-23 ps, presumably for co-facial arrangements) can occur 15-50 times faster than Auger recombination and demonstrate multiexcitonic FRET, making such materials ideal candidates for advanced technologies.

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