NSF NANOSCALE SCIENCE AND ENGINEERING GRANTEES CONFERENCE: NANOTECHNOLOGY FOR SUSTAINABLE SOCIETY
DECEMBER 7-8, 2022

PHOTON TRANSFORMERS: RELAXING QUANTUM CONFINEMENT IN NANOCRYSTAL-SENSITIZED PHOTON UPCONVERSION

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Abstract: Triplet generation at a hybrid inorganic/organic semiconductor interface is a promising approach to increase the (photo-)excited state lifetime, and thus, facilitate energy harvesting. One possible application is photon upconversion, which is the process of shortening the wavelength of the light emitted upon irradiation, resulting in a net gain in photon energy. To comply with energy conservation laws, triplet-triplet annihilation upconversion occurs by combining two or more low energy photons. Since direct optical excitation of triplet states is spin-forbidden, sensitizers are required to indirectly populate the triplet state by energy or charge transfer. Triplet sensitizers span a broad range of material classes including metal-organic complexes, nanomaterials, and bulk perovskite films. Understanding the fundamental energy transfer mechanism is crucial for the advancement of optoelectronic devices based on this process.
The exact triplet sensitization mechanism varies depending on several factors including: (i) the absolute alignments of the sensitizer and acceptor energy levels. (ii) The exciton binding energy in the sensitizer, resulting in excited states in form of excitons or free carriers. (iii) Energetic polydispersity of a sample, which varies the energetic driving force for triplet transfer. Here, I will present the current understanding of the triplet sensitization mechanism based on two-dimensional CdSe nanoplatelets.

Bio: Professor Nienhaus began her independent career at Florida State University in the Fall of 2018. In 2015, she obtained her Ph.D. from the University of Illinois at Urbana-Champaign working with Professor Gruebele on optical absorption detected by scanning tunneling microscopy. Following her PhD, she moved to MIT to work with Professor Bawendi on nanocrystal-sensitized solid-state photon upconversion and bulk perovskite materials using optical spectroscopy.
The Nienhaus group has been focusing on developing triplet sensitizers with varying dimensionalities for photon upconversion and is currently working to unravel the complex photophysical processes occurring in these systems by utilizing a combination of optical spectroscopy and scanning probe microscopy.