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Playing with Excitons in Semiconductor Quantum Dots

Quantum confinement effects in semiconductor nanocrystals allowed newer possibilities in tuning their physical properties by varying the size and shape. Photoexcitation of semiconductor quantum dots (QDs) generate a bound electron-hole pair called exciton. The first part of the talk I shall provide an overview on various approaches adopted for tuning the excitonic emission of semiconductor QDs from a historic perspective, highlighting following aspects: (i) quantitative description of the electronic properties of semiconductor nanocrystals as a function of size and shape, (ii) experimental demonstration of the quantum confinement effects in QDs, (iii) various synthetic approaches adopted for the design of well-defined nanometer sized crystallites and engineering their surfaces. In the second part of my talk I shall discuss the recent efforts to understand the interfacial properties, heterojunctions and trap-states in semiconductor QDs. I shall also discuss the optical properties of QDs with emphasis on the resonance energy transfer and light induced electron transfer. Finally, I will explain our recent approaches to understand the electron transfer in QDs by using time-resolved absorption techniques in the nanosecond and femtosecond time scales and time-resolved fluorescence techniques at a single particle level. I shall conclude my presentation highlighting the technological developments emerged out of the physics and chemistry of QDs and future challenges.

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George Thomas has made significant contributions in several areas of photosciences and nanomaterials which include light-matter interaction at the nanoscale focusing on molecular systems, plasmonic systems and semiconductor quantum dots using steady-state and time-resolved spectroscopy and single- molecule/particle spectroscopy and microscopy. He is the recipient of several awards and distinctions He was awarded the Shanti Swarup Bhatnagar Prize in Chemical Sciences in 2006 and J C Bose National Fellowship in 2014. He is an elected fellow of the Indian National Science Academy, New Delhi and Indian Academy of Sciences, Bangalore. In 2020, he received C N R Rao prize lecture in advanced materials awarded by the Chemical Research Society of India. Professor George is currently serving as the President of the Asian and Oceanian Photochemistry Association and Dean, Faculty affairs of Indian Institute of Science Education and Research Thiruvananthapuram. Twenty three students completed their doctoral degree under his supervision now occupying important positions as faculty members in prestigious Indian and foreign Universities.