S N BOSE NATIONAL CENTRE
FOR BASIC SCIENCES
Block JD, Sector III, Salt Lake, Kolkata 700 106

DEPARTMENTAL SEMINAR

Chemical, Biological & Macro-Molecular Sciences

12th JULY, 2022   4.00 PM   BOSON / ONLINE

SPEAKER

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TITLE OF THE TALK

Designing Two-dimensional Colloidal Nanocrystals for Opto-electronic Applications

ABSTRACT

Colloidal nanocrystals (CNCs) are solution-processed materials which are suitable for low-cost and scalable opto-electronic applications. Two-dimensional (2D) semiconductor CNCs, also known as nanoplatelets (NPLs), represent a special class of materials where excitons share the benefits of strong confinement in the vertical direction (control the bandgap) and weakly bound motion in the lateral dimensions.[1] The thicknesses of 2D NPLs can be controlled with atomic precision from just a few to several atomic layers (typically < 3 nm), so no inhomogeneous PL line broadening is observed at room temperature. Large lateral sizes determine optical properties such as the photoluminescence (PL) lifetime and nonradiative recombination rate. Thus, along with the advantages of colloidal quantum dots (for instance, solution processability, widely tunable light absorption and emission with high quantum yield), NPLs exhibited additional unique spectroscopic properties, such as high extinction coefficients, sharp band-edge transitions, ultranarrow emission bandwidths, fast exciton recombination rates, exceptionally large exciton and biexciton binding energies, and suppressed Auger recombination. Therefore, the rational design of 2D NPLs has attracted a lot of interest recently to engineer their opto-electronic properties for advanced photonic and electronic applications. In this talk, I will discuss our recent results of CdSe-based 2D CNCs, featuring dimension-controlled CdSe NPLs suitable as phosphors for lasing or light emitting devices,[2] as well as the incorporation of heterovalent dopants (CdSe:Ag NPLs)[3] which exhibit PL that is strongly Stokes shifted and has a lifetime beyond 100 ns, and 2D heterostructured architecture (CdSe/CdS/CdTe NPLs)[4] in the latter case the CdS barrier yields emission from CdSe and CdTe direct transitions along with the Type-II emission. This flexibility to design 2D heterostructures has led to a wide range of applications from luminescent solar concentrators to ultrafast scintillators and fluorescence upconversion. To further tune the emission spectrum, we introduced 2D PbS NPLs using a single-source precursor approach.[5] Their sharp NIR emission features are promising for solution-processed photonic devices.

Contd….pg :2

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[5] A. H. Khan et al., Chem. Mater. 2017, 29, 7, 2883-2889.

HOST FACULTY

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