SEMINAR SERIES

HIGHLIGHTS IN ENERGY RESEARCH

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Two-Dimensional Colloidal Quantum Wells for Future Photonic Sources

Prof. Chih-Jen SHIH

Department of Chemistry and Applied Biosciences, ETH Zurich

Host : Prof. Kumar Agrawal

Miniaturized photonic sources based on semiconducting two-dimensional (2D) materials offer new technological opportunities beyond the modern III-V platforms. For example, the quantum-confined 2D electronic structure aligns the exciton transition dipole moment, directing emission perpendicular to the surface which gives rise to high-efficiency quantum optics and electroluminescent devices. It requires scalable materials and processes to create the decoupled multi-quantum-well (MQW) superlattices, in which individual 2D material layers are isolated by atomically thin quantum barriers (QBs). My research group developed synthetic routes to obtain monodispersed, quantum-confined colloidal quantum wells (CQWs) of lead halide perovskites with precise thickness control, yielding different emission colors without altering the chemical composition. We successfully developed the protocols fabricating the thin-film MQW superlattices out of these materials. Unexpectedly, an enhancement of PLQY with respect to colloidal dispersions was observed, and individual QWs can be decoupled with unprecedentedly ultrathin QBs that screen interlayer interactions within the range of 6.5 Å. These unique phenomena were investigated in order to uncover the underlying physical mechanisms. The photonic sources demonstrated here have narrowband emission together with high quantum yield, directionality, and wavelength tunability, which are highly desirable for many near-field and far-field applications such as nanoantennas and light-emitting diodes.

Bio : Chih-Jen Shih has been a tenure-track assistant professor of chemical engineering at the Department of Chemistry and Applied Biosciences, ETH Zurich since 2015. He was trained in Stanford University (Postdoc, 2014-2015) and Massachusetts Institute of Technology (PhD, 2009-2014). His research group focuses on morphology, dynamics, molecular forces, and transport phenomena at nanomaterials interfaces. His interest ranges from fundamental understanding of how dielectric screening of atomically thin nanomaterials influences the movement and interactions of charges, excitons, and molecules near interfaces, to application-motivated studies aimed at developing new engineering strategies to control over the interplay of these mechanisms, towards new technological opportunities in optoelectronics, sensors, and actuators. His research has been recognized by the Victor K. LaMer Award from the American Chemical Society, the Ruzicka Prize from the Swiss Chemical Society, and the ERC Starting Grant from the European Union.