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IAPME Seminar

The first decade of colloidal perovskite quantum dots: Quo Vadis?

24 June 2025

Prof. Maksym V. Kovalenko
ETH Zürich
Venue: N23-4018
Time: 11:00 - 12:00
Hosted by: Prof. Handong SUN

Abstract

This year marks the first decade of colloidally synthesized lead halide perovskite quantum dots (LHP QDs), defining QDs as size- and shape-uniform ensembles with tunable quantum confinement and single-photon emission. Gradually, during this period, practically the entire compositional within a general formula APbX3 was thoroughly studied, with A being cesium (Cs), methylammonium (MA), formamidinium (FA), and azeridinium (AZ) was produced as high-quality nanocrystals. This journey is, arguably, at its very beginning. The LHP QDs are vastly different from conventional, more covalent semiconductors – they are ionic compounds with much lower formation energies, entropically stabilized, and structurally dynamic. The design of surface capping ligands turned out to be decisive for their stabilization at the nanoscale and for taming their photophysics. Currently, LHP NCs are prototyped as primary green emitters for television displays owing to facile and scalable production, higher emissivity-per-mass under blue excitation, and narrow emission linewidth. Their excitonic characteristics exceed initial expectations in many regards, opening opportunities as quantum light sources. In particular, at cryogenic temperatures, LHP QDs exhibit long excitonic coherence times, which start to match the fast sub-100 ps radiative rates. Both characteristics are optimized, to our surprise, in larger CsPbX3 QDs beyond the quantum confinement, namely, 20-40 nm, owing to the single-photon superradiance effect (giant oscillator strength at the single-exciton per NC regime). Single-component and multicomponent QD superlattices exhibit collective emission, known as superfluorescence, characterized by the oscillating, ultrafast (10-30 ps) radiative decays. This presentation will walk you through both the most essential progress over this first decade, including our current work, and outline future prospects.

Biography

Prof. Maksym V. Kovalenko is a Full Professor of Functional Inorganic Materials at ETH Zurich. He studied chemistry at the Chernivtsi National University in Ukraine from 1999 to 2004. He completed his doctoral studies at the University of Linz, Austria (2004-2007), and his postdoctoral training at the University of Chicago, USA (2008-2011). He then joined ETH Zurich as a tenure-track professor and became a tenured Associate Professor in 2017; promoted to Full Professor in 2020. Currently, he serves as the head of the Institute of Inorganic Chemistry. He is also an associate editor of the Chemistry of Materials and ACS Materials Au. The research activities of M. Kovalenko and his group focus on chemistry, physics and applications of inorganic solid-state materials and nanostructures.

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