Plenary Speakers

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Short Biography

David J. Norris received his Ph.D. in physical chemistry at MIT in 1995 under the guidance of Moungi Bawendi (Nobel Laureate, Chemistry 2023). After an NSF postdoctoral fellowship at the University of California, San Diego with W. E. Moerner (Nobel Laureate, Chemistry 2014), he started his own research group at the NEC Research Institute in Princeton (1997). He then became an Associate Professor (2001–2006) and Professor (2006–2010) of Chemical Engineering and Materials Science at the University of Minnesota. In 2010 he moved to ETH Zurich, where he is currently Professor of Materials Engineering. From 2016 to 2019, he served as the Head of the Department of Mechanical and Process Engineering. He has received the Credit Suisse Award for Best Teacher at ETH, twice the Golden Owl Award for Best Teacher in his department, the Max Rössler Research Prize, an ERC Advanced Grant, and the ACS Nano Lectureship Award. He is a Fellow of the AAAS, APS, and Optica, and an editorial board member for ACS Applied Optical Materials, ACS Photonics, and Nano Letters.

Title of Oral Presentation

Better Quantum Dots through Magic Sizes and Bright Excitons?

Keywords (5 words max)

quantum dot, semiconductor nanocrystal, magic-sized cluster, dark exciton, bright exciton

Abstract of Oral Presentation

Semiconductor quantum dots now provide versatile color-tunable fluorescent materials for a variety of light-emitting devices, including flat-panel televisions. However, despite decades of research, they still suffer from two issues. First, even the best quantum-dot syntheses yield samples with distributions in particle size and shape. This polydispersity reduces optical performance by broadening the absorption and emission linewidths. Second, quantum dots suffer from the “dark exciton,” an optically inactive state in which an excited quantum dot gets stuck before emitting. Here, we will discuss our efforts to address these two issues. First, we will review magic-sized clusters, molecular-scale arrangements of atoms with a structure that is more stable than particles slightly smaller or larger. Magic-sized clusters grow by jumping between a series of discrete “magic” sizes, which are, in principle, uniform in size and shape. Interestingly, experiments have tracked the discrete evolution of magic sizes into the quantum-dot regime. After describing a proposed growth mechanism for these magic-sized nanocrystals, we will probe whether this understanding can lead to more uniform quantum dots for applications. Second, we will review the discovery of the dark exciton in the 1990s, unsuccessful efforts to avoid its impact over two decades, and finally our recent identification of “bright-exciton” quantum dots. Specifically, a theoretical mechanism was discovered in 2018 that can overcome the dark exciton. We have exploited our understanding of this mechanism to search through 500,000 inorganic solids to identify materials with the proper physical properties. We then produce a list of potentially super-bright quantum dots, providing a roadmap for experimental investigation of new quantum-dot materials for applications.

Acknowledgement

References