

Seminar

Department of Materials Engineering

Thursday, December 25th, 2025, 11:00-12:00

Seminar Room (015) of Building 51 (Marcus Campus)

Insights into surfaces and subsurfaces of semiconductor nanocrystals

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Abstract:

Surface ligands play a central role in determining the structure and electronic properties of semiconductor nanocrystals. While inorganic ligand exchange is widely used to tailor nanocrystal functionality, the chemical nature of the modified surface remains poorly understood. This study demonstrates how solid-state NMR provides direct, site-specific insight into the surface chemistry of CdS nanocrystals undergoing inorganic ligand exchange.

I show that inorganic ligands do not simply replace native ligands but rather form chemically distinct surface structures. Different classes of inorganic ligands, phosphates, polyselenides, and thiostannates, give rise to markedly different interfacial chemistries, dynamics, and degrees of disorder, which directly influence electronic disorder and optical properties.

I further demonstrate that the impact of surface-ligand interface is not confined to the outermost atomic layer but extends several layers beneath the nanocrystal surface. These results establish that disorder in nanocrystals exists within the near-surface atomic structure rather than solely at the ligand shell. By linking atomic-scale structure to macroscopic electronic properties, this work highlights the importance of surface chemistry and subsurface in nanocrystal design and establishes solid-state NMR as a powerful tool for probing interfaces in functional nanomaterials.

Ran Eitan Abutbul, PhD is a Marie Skłodowska-Curie Postdoctoral Fellow in Chemical Engineering at the University of Manchester, working on the synthesis, phase engineering, and surface chemistry of semiconductor nanocrystals. His research integrates colloidal nanomaterials synthesis with advanced solid-state and DNP-enhanced NMR spectroscopy to achieve atomic-level insight into nanocrystal interfaces and metastable structures. He has published 26 peer-reviewed articles in leading journals, including *JACS* and *ACS Nano*, with over 650 citations, and is the recipient of several competitive fellowships.



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