Seminar title:
Nanoscale Imaging of Catalytic Activity in Semiconductor Nanostructures Using Single-Molecule Fluorescence Microscopy

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Abstract:
Semiconductor nanocrystals are promising candidates for generating chemical feedstocks through photocatalysis using photoexcited charge carriers to perform charge-transfer reactions. However, the fate of photoexcited charges once they reach the surface, i.e., whether they recombine or are extracted to initiate useful redox reactions, is highly sensitive to the structure of the surface. Our research group is currently investigating how oxygen vacancies, a type of crystal defect in metal oxide semiconductors, control their photocatalytic activity. Using single-molecule, super-resolution microscopy, we are imaging spatial and temporal variations in the photocatalytic activity of individual nanocrystals including bismuth oxybromide and tungsten oxide. To understand the chemical origins of these variations in activity we apply a combination of ensemble structural characterization, electronic-structure calculations, and the quantitative spatial correlation of multiple fluorogenic probes. Our results show that both irradiation and chemical modifications to the surface semiconductors nanocrystals can be used to tune the concentration and distribution of oxygen vacancies in these materials, which has a significant impact on their resulting catalytic activity. I will show how in one system, bismuth oxybromide, a high concentration of oxygen vacancies decreases activity, while in tungsten oxide, it increases activity.

Sadtler Bio: Bryce Sadtler graduated from Purdue University in 2002 with a B.S. degree in Chemistry. He conducted his graduate studies at the University of California, Berkeley under the guidance of Paul Alivisatos and received a Ph.D. in Physical Chemistry in 2009. He was then a Beckman Institute Postdoctoral Fellow at the California Institute of Technology, where he worked with Nathan Lewis and Harry Atwater. Bryce joined the Department of Chemistry at Washington University in St. Louis in the fall of 2014. His research interests include solid-state chemistry and light–matter interactions in nanoscale materials for applications in solar energy conversion and catalysis. As an assistant professor, he has received an NSF Career award (2018), an ACS PRF Doctoral New Investigator Award (2017), and was named an Emerging Investigator by the Journal of Materials Chemistry (2017). Bryce will be promoted to an Associate Professor at Washington University in July 2022.