University of Louisville
Department of Chemistry

Fahad Bin Halim

Literature Seminar

When: January 12, 2022
Time: 2:30 p.m.
Location: CBLL-16

"Visualizing the Morphological Changes of Nanoparticles by X-ray Ptychography"

Abstract:
X-ray ptychography is an emerging coherent diffractive imaging technique with the ability to image large fields of view at high resolution. It allows imaging of non-isolated specimens and can produce quantitative mapping of the electron density distribution in 3D when combined with computed tomography.[1] The technique has applications in many research areas, including material science, biology, electronics, and optics. However, in recent times, X-ray ptychography has been applied to nanoparticle research to demonstrate non-destructive three-dimensional imaging of complexly organized nanoparticles and multimaterial frameworks. For example, Gang and co-workers imaged arrangements of nanoparticle assembly motifs and a resulting multimaterial framework with elemental sensitivity. Furthermore, the real space reconstruction allows for direct three-dimensional imaging of lattices, which reveals their imperfections and interfaces and clarifies the relationship between lattices and assembly motifs. Thus, by better understanding the lattice framework and assembly motifs, there can be progress in the development of self-assembly strategies, which can enable the formation of complex nanoscale architecture.[2] Grote *et al.* reported in-situ nanoimaging of the formation and hollowing of Copper oxide nanocubes in solution by X-ray ptychography. The in-situ imaging of the growth of the nanocubes in solution, interaction of nanoparticles with the exit polyimide window, and the reduction of copper oxide to copper, which triggered the hollowing of the nanocuboids, revealed full morphological growth of copper oxide nanocuboids and their subsequent transformation into hollow copper structures in solution.[3] Zheng *et al.* applied X-ray ptychography to image the internal structure of DNA-assembled superlattices, revealing that the superlattices, which appeared single-crystalline in scanning electron microscopy, may have subsurface grain boundaries. In addition, the work showed the application of X-ray ptychography in gaining insight into nanoparticle crystallization.[4] In summary, X-ray Ptychography provides a better understanding of the morphology of nanoparticle assemblies, and such images can be utilized to design nanoparticles for applications in the field of catalysis, biochemistry, electronics, and optics.

References:

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2. Michelson,A.; Hamed Emamy,BM.; Huang,X.; Chu,YS.; Yan,H.; Gang,O.; 2022. Three-dimensional visualization of nanoparticle lattices and multimaterial frameworks. *Science*, 376 (6589), DOI: 10.1126/science.abk0463
3. Grote, L.; Seyrich, M.; Döhrmann, R.; Harouna-Mayer,S Y.; Mancini,F.; Kaziukenas,E .; Fernandez-Cuesta,I .; Zito,C A.; Vasylieva,O .; Wittwer,F .; Odstrczil,M .; Mogos,N .; Landmann,M .; Schroer,C G.; Koziej,D.; 2022. Imaging Cu_2O nanocube hollowing in solution by quantitative in situ X-ray ptychography. *Nat Commun* 13, 4971.
4. Zheng, C Y .; Yao,Y.; Deng,J.; Seifert,S.; Wong,A M.; Lee,B .; Mirkin,C A.; 2022. Confined Growth of DNA-Assembled Superlattice Films. *ACS Nano 16* (3), 4813-4822. https://doi.org/10.1021/acsnano.2c00161