Through the Lens: Exploring Chemistry with Transmission Electron Microscopy

This presentation comprises two sections. In the first segment, I will expeditiously address the challenges associated with obtaining high-resolution (scanning) transmission electron microscopy ((S)TEM) images for materials sensitive to electron beam irradiation. Additionally, I will introduce innovative techniques developed to surmount these challenges, including ultralow-dose high-resolution TEM (HRTEM) [1-3], integrated differential phase contrast STEM (iDPC-STEM) [4], and ptychographic reconstruction based on four-dimensional STEM (4D-STEM) data [5]. If time permits, I will also provide a brief overview of cryogenic focused ion beam (cryo-FIB) as a specimen preparation method for (S)TEM [6]. In the second part of the presentation, I will illustrate the practical application of (S)TEM in the realm of chemical research and related disciplines through several compelling examples.

References

[1] Unravelling surface and interfacial structures of a metal-organic framework by transmission electron microscopy. Nat. Mater. 2017, 16, 532-536.

[2] Atomic-resolution transmission electron microscopy of electron beam-sensitive crystalline materials. Science 2018, 359, 675-679.

[3] Imaging defects and their evolution in a metal-organic framework at sub-unit-cell resolution. Nat. Chem. 2019, 11, 622-628.

[4] Direct Imaging of Atomically Dispersed Molybdenum that Enables Location of Aluminum in the Framework of Zeolite ZSM-5, Angew. Chem. Int. Ed., 2020, 59, 819-825

[5] Three-dimensional inhomogeneity of zeolite structure and composition revealed by electron ptychography. Science 2023, 380, 633-638.

[6] Cryogenic focused ion beam enables atomic-resolution imaging of local structures in highly sensitive bulk crystals and devices. J. Am. Chem. Soc. 2022, 144, 3182-3191.