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Electron Microscopy Imaging of Highly Sensitive Crystalline Chemical Materials

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This presentation will focus on our recent works pertaining to the high-resolution imaging of electron beam-sensitive materials using ultralow electron doses. The following technological advances will be discussed. First, the development of a suite of methods to address the challenges peculiar to low-dose TEM imaging, including rapid search for crystal zone axes, precise alignment of the image stack, and accurate determination of the defocus value, enables efficient imaging of electron beam-sensitive crystalline materials in the high-resolution TEM (HRTEM) mode [1-3]. Second, integrated differential phase contrast STEM (iDPC-STEM) has proven to be an effective method for acquiring directly interpretable atomic-resolution images under low-dose conditions [4]. Third, I will share my views on the great potential of four-dimensional STEM (4D-STEM) electron ptychography in imaging highly electron beam-sensitive materials and provide preliminary results to demonstrate its feasibility [5-6].

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] Atomically resolved imaging of radiation-sensitive metal-organic frameworks via electron ptychography. Nat. Commun. 2025, 16, 914.