Probing 3D Structures of Nanoporous Materials by Transmission Electron Microscopy and Electron Diffraction

Xiaodong Zou, Berzelii Center EXSELENT on Porous Materials and Inorganic and Structural Chemistry, Department of Materials and Environmental Chemistry, Stockholm University, Stockholm

The properties of materials are closely related to their structures. Knowing the three-dimensional (3D) atomic structures is essential to understand the properties and modify the functionalities. Transmission electron microscopy and electron diffraction are among the most powerful techniques for studying crystals too small to be studied by single crystal X-ray diffraction or too complex to be studied by powder X-ray diffraction. A major drawback is that each transmission electron microscopy (TEM) image or electron diffraction (ED) pattern contains only 2D information (projection) of the material. Here I will give introduce electron crystallography and present several TEM/ED approaches to probe the 3D structures of porous materials: rotation electron diffraction (RED), 3D reconstruction from a series of high-resolution transmission electron microscopy (HRTEM) images, and electron tomography (ET). I will demonstrate the RED method on structure solution of unknown zeolites, metal-organic frameworks and covalent organic frameworks. I will present the study of structures and disorders in zeolites by HRTEM. Finally I will demonstrate the power of combining RED and ET for studying hierachical micro- and meso-porous structures in zeolites. The methods are general and can be applied to other materials.

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