

Solving 3D Nanostructures Using Ptychographic Atomic Electron Tomography

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Scanning transmission electron microscopy (STEM) has been successfully applied to solve many 3D nanostructures, using recently developed atomic electron tomography (AET) methods. To date, most of these STEM AET studies have relied on annular dark field (ADF) imaging, which provides approximately linear and incoherent contrast. This makes the 3D tomographic reconstruction procedure robust and easy to apply, but it can only be used for materials with medium or high atomic numbers which can tolerate a high electron dose without damage, and can struggle to distinguish atomics with similar scattering profiles.

Moving beyond these limitations will require multi-dimensional imaging channels. For example, in addition to the ADF measurement channel, chemical information can be simultaneously recovered using energy dispersive x-ray (EDX) mapping or electron energy loss spectroscopy (EELS). Combining these measurement channels with multi-modal sensor fusion and modern computational imaging methods will increase the amount of information recovered in AET experiments. Another multi-dimensional imaging channel available is to use fast direct electron detectors to recover full images of the diffracted STEM beam for each probe position. This combined with computational methods enables ptychographic imaging, where the STEM probe is fully deconvolved from the imaged object, allowing for extremely dose-efficient reconstructions. Additionally, advanced ptychography algorithms can correct for multiple scattering of the electron beam and limited coherence to further improve the spatial and angular resolution. In this talk, I will demonstrate the promise of ptychographic AET by solving the structure of a complex ZrTe nanowire embedded in a double walled carbon nanotube and discuss how we can develop a general reconstruction framework incorporating any number of simultaneous measurement channels.

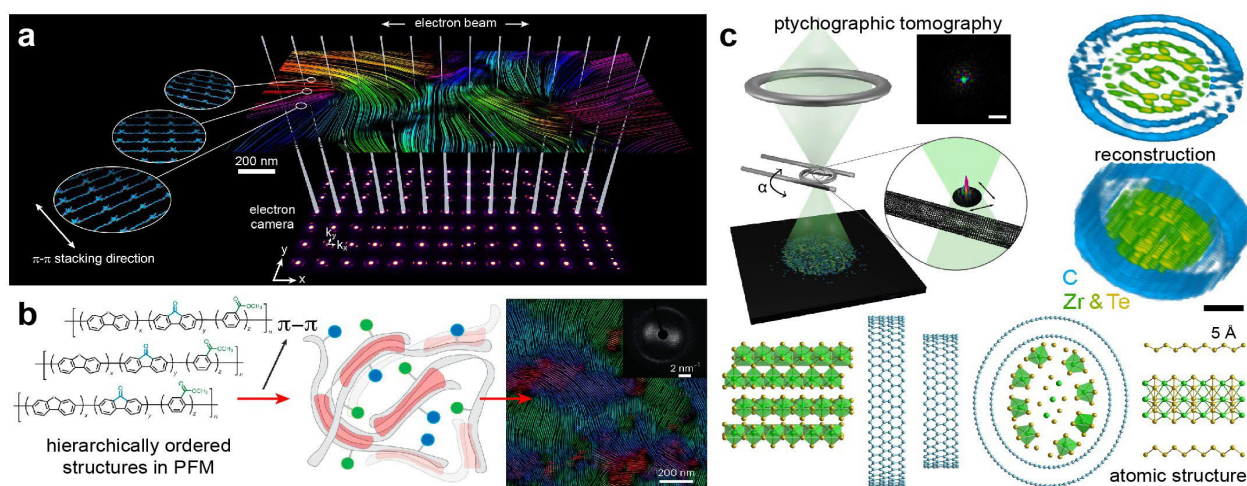


Figure 1