

## **The Changing View of the STEM: from Characterization, to Fabrication, to Synthesis**

The invention of the electron microscope dates back to 1932. From its inception observation of deposition and sample damage have been reported, yet it has only been relatively recently (2017) that the scanning transmission electron microscope (STEM) has begun to be used to intentionally perform sample alterations at the atomic scale. This represents an 85 year delay between invention and manipulation. In contrast, the scanning tunneling microscope (STM) was invented in 1982 and in just 8 years was beginning to be used for atomic manipulation.

This comparatively long delay between invention and manipulation raises some questions regarding the fruitfulness of current efforts in this direction. Surely, it has occurred to electron microscopists in the past to use this technology for atomically precise fabrication. If several generations of electron microscopists have not made headway in this direction is it not safe to conclude that current efforts are doomed to a similar fate?

In this talk, I will make the case that the time is right for atomic manipulation using electron beams. I will discuss various technological improvements that set the stage for current efforts and the changing attitudes toward the instrument. I will provide examples from the wider literature to illustrate the recent conceptual shift from characterization to fabrication and highlight our further conceptual shift from fabrication to synthesis. This conception marries global, bottom-up processes with local, top-down processes in a generalized conception of e-beam induced deposition. I will argue that this approach represents the future of electron beam atomic fabrication.