Atomic-scale, real-time characterization of solid-state catalysts under gas-phase reaction conditions can provide unique information about reaction mechanisms. However, atomic-scale resolution is extremely difficult to achieve without the use of cryogenic temperatures and ultrahigh vacuum. Just a few months after receiving the L’Oreal-UNESCO Women in Science Award for developing the environmental scanning transmission electron microscope (E-STEM), Pratibha Gai, the JEOL Professor and Yorkshire Forward Chair of Electron Microscopy from the University of York, UK, with Edward Boyes, who is co-director of the York JEOL Nanocentre, has designed a new environmental scanning TEM.

The E-STEM technology, published in the June issue of *Annalen der Physik* (DOI 10.1002/andp.201300068; p. 423), enables characterization of single atoms, small clusters, and nanoparticles in dynamic experiments. The instrument enhances the atomic-scale resolution of the E-TEM, and now incorporates full scanning functionality, aberration correction, diffraction analysis, and high-angle annular dark-field imaging. For *in situ* studies, the microscope can operate at >500°C in pressures of >0.1 mbar at the sample. Gai, who co-directs the York JEOL Nanocentre, said that the E-STEM “opens up exciting new opportunities for observing and studying reacting atoms.”

To demonstrate the capabilities of the new microscope, Gai’s research team examined Pt deposited on an amorphous carbon support. At temperatures of up to 400°C in 0.02 mbar hydrogen, the instrument was able to resolve both single Pt atoms and larger Pt nanoparticles. The persistence of isolated atoms can have ramifications for reactivity and particle growth, and Gai said that the work “reveals the importance of dynamic single atoms in catalysis in the reaction conditions.” Additionally, the temperature dependence of the nanoparticle structures was observed, as the clusters evolved from disordered 1–2 layer discs to more cube-like configurations when heated for 30 minutes at 500°C under hydrogen. At this temperature, single atoms were not observed to the same extent due to either their incorporation into the larger particles or their increased mobility at the elevated temperature.

Mingwei Chen of Tohoku University, who was not involved with the work, asserts that the new E-STEM “is a promising technique to help us to solve many important catalysis-related questions.” However, despite the vast improvement in operating pressure that the new E-STEM allows, both Chen and Gai agree that a further increase would be valuable. The pressures currently available to the instrument are enough to saturate the surface of the sample, but higher pressures would provide access to more catalytic reactions. Gai said that the research team is “going in stages” to improve the pressure range by orders of magnitude in the coming months.

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