Model and Real Catalysts: Bridging the Complexity Gap

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In the last decade, there was a surge in advanced characterization methods to study catalytic materials at work. Most notable innovations in synchrotron-based techniques include the coupling of x-ray absorption and scattering methods to vibrational spectroscopies, empowered by improved time (QEXAFS) and energy (HERFD) resolutions. We will revisit the pros and cons of the two alternative approaches: 1) synchronous application of multiple techniques in a single experiment, and 2) design and applications of a portable reactor, suitable for multiple experiments with one technique at a time. We will also discuss the "structure-property-function-design" paradigm of catalysis science with the emphasis at the weakest link in this chain (between "structure" and "property"). Learning how to characterize some of the previously unexplored, yet explicitly anomalous, mesoscopic phenomena exhibited by model catalysts is possible by controlling their size, shape, support and adsorbate interactions. We will demonstrate how these factors affect thermal, structural and electronic properties of supported metal clusters as well as their reactivity. We will conclude by discussing new strategies of characterizing spatially and temporally resolved structure and kinetics in real catalytic systems.