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In situ X-ray studies of model and real catalysts: Bridging the complexity gap

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In the last decade, there has been a surge in advancing synchrotron-based characterization methods to study catalytic materials. Most notable innovations include combining the X-ray absorption and scattering methods, and coupling of one or both of them to vibrational spectroscopies. I will report on recent developments at the Synchrotron Catalysis Consortium (SCC) at Brookhaven National Laboratory (BNL) on combining XAS, XRD, IR and Raman measurements in the same experiment for investigations of Water-Gas Shift reaction catalysts. While well-defined, model catalysts can be characterized by ensemble-average methods, new methodologies are sought to study real catalysts that possess broad compositional and structural distributions. XAS and XRD are not sensitive to local fluctuations in size, shape, structure and composition of nanomaterials, and the local information, such as one provided by electron microscopy, is needed. I will describe our advances at the SCC in coupling the in situ XAFS to the in situ environmental TEM measurements. The use of these methods will be demonstrated on the example of supported Pt clusters that exhibited unique thermodynamic properties. I will demonstrate the feasibility of conducting in situ and in operando catalytic experiments on the same system by XAS and TEM techniques using a specially designed environmental cell that is compatible both with x-ray absorption and electron microscopy probes.

Primary author: Prof. FRENKEL, Anatoly (Yeshiva University)

Presenter: Prof. FRENKEL, Anatoly (Yeshiva University)

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