325e Bridging the Liquid Gap: in-Situ Vibrational Spectroscopy of Solid-Liquid Catalytic Interfaces

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Solid-catalyzed liquid-phase reactions are poised to play an increasingly important role in the fine chemicals and pharmaceuticals industries, as well as the area of catalysis of biorenewables. When compared to currently used homogeneous catalytic methods, heterogeneous catalysts can offer some advantages, including ease of separation and handling, and possible reduced use of solvent. In order to gain an understanding of how such heterogeneous catalysts function, there is a need for in-situ surface chemical information to be obtained. However, while surface characterization of solid catalyst-gas interfaces with vibrational (and other) spectroscopic methods has received much attention over the years, there has been relatively little effort to extend these approaches to solid-liquid catalytic systems. This situation has persisted largely due to the inherent difficulties of studying such “buried” interfaces. Chief among these is the large spectral interference caused by the bulk phase, which makes it very difficult (and sometimes impossible) to extract surface information. This talk will discuss the application of two novel surface vibrational approaches to the study of solid-liquid catalytic interfaces: attenuated total reflection infrared spectroscopy (ATR-IRS) and total internal reflection sum-frequency spectroscopy (TIR-SFS). Some background on these approaches will be provided, along with the theoretical and experimental considerations related to catalytic studies. The advantages and disadvantages of each approach will be highlighted using recent results from our laboratory, with a focus on nitrile adsorption and hydrogenation on oxide supports (e.g., Al_2O_3 , ZrO_2) and on supported metal catalysts (e.g., Pt/Al_2O_3) in hexane. The prospects of using these approaches for future in-situ catalytic investigations will be considered.