How local environments impact chemical reaction dynamics: Raman spectroscopy on the nanoscale

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My research program is broadly interested in spectroscopically determining how local environments affect chemical reaction dynamics. We focus on highly heterogeneous systems such as cellular membranes or photocatalytic devices, developing and using new spectroscopic approaches to probe structure and function on relevant length scales. This talk will focus on two approaches to nanoscale Raman spectroscopies, techniques that are capable of monitoring chemical composition and dynamics in the nanometer regime. First, I’ll present how we use plasmonic nanomaterials, which interact strongly with light and confine it to nanometer length scales, to probe and drive new chemical reactions. We use surface-enhanced Raman spectroscopy on ultrafast timescales to monitor plasmon-molecule interactions in real time. Currently, we are investigating the use of these nanomaterials to provide highly energetic carriers and localized heating for photocatalysis. Secondly, I will discuss the development and implementation of a new super-resolution Raman microscopy technique which is capable of probing chemical composition on the 50 nm length scale. This label-free sub-diffraction imaging technique should have numerous applications in chemically-specific microscopy of soft and dynamic materials, including biological samples. I’ll discuss our method of achieving resolution well below the optical diffraction limit, implementation of this new technique, and approaches to reaching resolution on the nanometer length scale.