Monitoring Photocatalytic Reactions Using Surface Enhanced Raman Spectroscopy

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Recent studies show increasing amounts of harmful organic pollutants in wastewater. Fortunately, organic pollutants can be broken down into harmless end products via photocatalytic degradation. However, more information on the intermediates of these reactions is needed to determine their safety. Ideally, Raman spectroscopy can be used to monitor reactions in real time, 100 times faster compared to the slow process of Gas Chromatography-Mass Spectrometry (GC-MS). However, Raman spectroscopy has low sensitivity, so some molecules that are not strongly Raman active at low concentrations (such as 10-5-M) do not produce high enough Raman intensity in water to be observed. To counteract this dilemma, gold nanoparticles can be used to greatly enhance the Raman intensity of molecules in water, termed Surface Enhanced Raman Spectroscopy (SERS). Gold nanoparticles aggregate to form large clusters of nanoparticles which could precipitate and lower the overall Raman intensity. A capping agent can be used to prevent aggregation by arresting the formation of large clusters. Using the stable (“capped”) nanoparticles, photocatalytic reactions can be monitored by assessing the changes in the Raman spectrum of the molecule being monitored. In this experiment, rhodamine 6G (R6G), a common dye and organic pollutant, and paraquat, a pesticide, were used as the analytes being monitored and sodium dodecyl sulfate (SDS) was the capping agent for the gold nanoparticles. Also, at most acidic pH levels (below pH 5), the capped nanoparticles were unstable yet were stable at basic pH levels (up to pH 12), and a reaction was observed between R6G and OH-.