Enhanced Raman spectroscopy of aerosol particles

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Raman spectroscopy is a widely used technique to measure vibrational and rotational molecular modes that can provide very specific spectral signatures for chemical identification. However, typically low Raman scattering cross-sections have been a barrier to using this technique for in situ characterization of environmental aerosols or monitoring hazardous materials present in the air. By combining metallic nano-particles (MNPs) with aerosol particles, we have been able to observe enhanced fluorescence (Sivaprakasam et al. 2014) and Surface Enhanced Raman Spectra. We have explored the comparison measurements of spontaneous Raman spectra with MNP-enhanced Raman spectra using identical materials under controlled conditions as aerosols and bulk liquid samples. The repeatability of spectral response and enhancement factors as well as their dependence on factors such as the MNP composition, MNP concentration, and material composition will be investigated.

A Raman spectroscopy test-bed has been constructed that is capable of interrogating single aerosol particles or bulk samples in a cuvette for comparison/validation studies. Aerosol particles are suspended in a linear electrodynamic quadrupole (LEQ) trap (Hart et al. 2015) that gives us ample time to study the weak spontaneous Raman for extended periods of time. Aerosol particles are created and charged using a customized nozzle-reservoir droplet generator, and particles ranging from 1 to 60 micrometers in diameter have been successfully generated and maintained. For validation and calibration, droplets of materials such as glycerol and dibutyl sebacate were studied, using a 532-nm laser for excitation. Initial SERS has been observed and studied for Pyridine and Rhodamine laser dye, plans to extend the study to other chemicals and proteins are under way. The latest results in terms of spectral signatures resulting from the addition of the MNPs to these materials will be presented.

References


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