HELIUM NANODROPLETS: A GIFT TO THE SPECTROSCOPIST

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Helium nanodroplets have immerged as a novel medium for forming and spectroscopically characterizing a wide range of clusters and nanoscale materials. Infrared laser spectroscopy has proven to be particularly powerful, given that the resolution in the associated spectra is often very high. In fact, the spectra of solvated molecules and clusters often show well resolved rotational (and sometimes hyperfine) structure that can be used to either probe the nature of the interactions between the dopant and the helium solvent or to probe the structure of the clusters formed in the droplets. The number of atoms and/or molecules doped into the droplets can be varied at will by passing the droplets though a chamber maintained at an appropriate partial pressure of the species of interest.

Free radical clusters are being formed in helium nanodroplets and studied using high resolution infrared laser spectroscopy. The radicals are formed by pyrolyzing a suitable precursor molecule, using a high temperature source. We currently have sources for I, Br, Cl, F and a range of organic radicals. Other approaches are being developed for N and O atoms and OH and CN radicals. Pick-up of the radicals is accomplished by passing the helium droplet beam close to the exit of the source. Complexes containing metals, semiconductors, salts, and biomolecules have also been formed and spectroscopically investigated. In several cases, we clearly show that the rapid cooling of the growing species in the helium results in the stabilization of highly metastable species that would be difficult or impossible to form using more conventional, gas phase techniques.