Electron driven reactions in doped He droplets

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Formation of positive and negative ions upon free electron collisions with doped nano-droplets of superfluid ^{4}He, are studied, utilizing a two sector field mass spectrometer. Simple diatomic molecules such as H_2 and I_2 are used as dopants as well as water, halocarbons, SF_6, CCl_4, amino acids, DNA bases and fullerenes. Molecules that collide with a droplet are picked up by the droplet and in most cases move to its center. Depending on the pressure in the pick-up cell either monomers or clusters of these dopants are formed in the droplet. Positive-ion mass spectra are recorded and compared with results obtained in the gas phase. The high mass resolution and sensitivity of the experimental setup is a prerequisite to identify novel product ions that are stabilized by the surrounding He, e.g., SF_6^+ and CCl_4^+.

For many dopants also negative (cluster) ion formation has been observed. The yield of these anions is measured as a function of the electron energy [1]. The molecules chosen for our first study were the nucleobases adenine, thymine and partially methylated or deuterated thymine. The DEA to these nucleobase molecules and clusters in helium droplets (see [1]) exhibits the remarkable site selectivity that we have previously established for these biomolecules in the gas phase [2]. Core excited resonances that lead to low mass fragment anions upon electron attachment in the gas phase are almost completely quenched and instead lead to the formation of dehydrogenated closed shell anions via loss of a neutral H-atom [3]. We have extended these studies to He droplets doped with several other molecules such as $CHCl_3$ [4], water [5], and ammonia. A surprisingly rich chemistry, driven by electrons, is observed at ultra-low (0.37K) temperatures.

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