INFRARED SPECTROSCOPY OF DEUTERATED ACETYLENE IN SOLID PARAHYDROGEN AND THE HELIUM RECOVERY INITIATIVE

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The linear tetratomic organic molecule acetylene, HCCH, has been studied extensively throughout the past century via numerous spectroscopic experiments, exploiting wavelengths across the electromagnetic spectrum. Both the mono- and di-deutero acetylene isotopologues have also been widely studied, namely HCCD and DCCD. In this presentation, I will present the Fourier transform infrared (FTIR) spectroscopy of DCCD in solid parahydrogen (pH_2) in the low-temperature regime (1.5-5.0 K). We intend to perform UV photochemical studies on DCCD doped solid pH_2 and, therefore, the infrared spectroscopy must be characterized prior. The FTIR spectrum of DCCD isolated in solid pH_2 exhibits rich fine structure in the ν_3 asymmetric C-D stretch region. Some of the observed peaks may arise from the formation of weakly bound acetylene dimers, or potentially even larger clusters. We can test this hypothesis by varying the DCCD concentration in separate experiments and temperature cycling the matrix to look for irreversible cluster growth. In preliminary experiments we observe trace amounts of the lighter isotopologues (HCCD and HCCH) and so these species can also cluster with DCCD, adding to the complexity of the spectra. We remark that ortho-hydrogen clustering to DCCD may also be occurring and we have ways to check that as well. In order to make better sense of the FTIR spectrum of DCCD doped pH_2, a comparison with the simulated low temperature gas-phase spectrum will also be presented. This will allow us to address issues related to the extent of the rotational motion of DCCD in solid pH_2.

A liquid helium bath cryostat is used to grow and maintain the DCCD doped pH_2 crystals for spectroscopic characterization. Helium is a non-renewable resource and in recent years the Anderson group has been building a helium recovery system. This Helium Recovery Initiative (HRI) will be discussed in an effort to describe how we implemented this new experimental system in our laboratory and to point out the major challenges we faced. One of the main goals of the HRI is to promote sustainable helium use, permitting smaller cryogenics laboratories to continue conducting research with liquid helium.