MATRIX ISOLATION SPECTROSCOPY OF ALUMINUM ATOMS AND ALUMINUM HYDRIDE SPECIES IN SOLID PARAHYDROGEN

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I describe our efforts towards the production and characterization of gram-scale cryogenic parahydrogen (pH_2) solids doped with large concentrations of Al atoms. Determination of the trapped Al atom concentrations from the measured ultraviolet (UV) atomic absorption spectra is problematic in such large column density (concentration x pathlength) samples, due to limitations on the dynamic range and signal-to-noise ratio achievable in absorption measurements. Fortunately, we can exploit the weak infrared (IR) activity induced by the Al atom dopants in neighboring pH_2 molecules as a diagnostic of the atomic concentrations. Our attempts to produce millimeters-thick samples containing Al atom concentrations in excess of 300 ppm have resulted in the apparent recombination and/or reaction of most of the Al atoms. We conjecture that when the pH_2 solid reaches a critical combination of Al concentration and sample thickness, the energy released upon occasional atomic recombination is no longer dissipated effectively, resulting in increased local temperatures and atomic mobilities, and ultimately leading to a recombination cascade which propagates rapidly throughout the sample. Reactions with the pH_2 host caused by recombining Al atoms or by intentional UV irradiation of Al/pH_2 samples results in the formation of a variety of aluminum hydride species which we observe via their IR absorptions.