PHOTODISSOCIATION OF DIBORANE ISOLATED IN SOLID PARAHYDROGEN: EVIDENCE OF SLOW DIFFUSION-CONTROLLED RECOMBINATION

AARON I. STROM, ANH H. M. NGUYEN, IBRAHIM MUDDASSER, DAVID T. ANDERSON, *Department of Chemistry, University of Wyoming, Laramie, WY, USA*.

Our group is interested in characterizing the diffusion of chemical impurities in quantum solids such as solid parahydrogen (pH_2). In this work we report FTIR studies of the 193 nm photodissociation of diborane (B_2H_6) isolated in solid pH_2 in the 1.5 K to 4.3 K temperature range. In the gas phase, diborane photodissociation at 193 nm has been shown to produce BH_3 with a quantum yield of 2.00(25).[a] In our studies, we deposit B_2H_6 in solid pH_2 and fully resolve vibrational peaks for the $^{11}B_2H_6$, $^{11}B^{10}BH_6$, and $^{10}B_2H_6$ isotopologs of diborane in natural abundance. We then photolyze the B_2H_6/pH_2 sample for a short period of time (30 min, 100 mW/cm^2) and observe the B_2H_6 peaks decrease in intensity as new peaks grow in. We suspect that we are producing BH_3 upon photolysis which forms a complex with the pH_2 host to form BH_3-pH_2. What we found surprising is that after we stop the 193 nm laser, we observe regrowth of the diborane peaks indicating that the photoproducts can readily diffuse through solid pH_2 even at the lowest temperatures studied (T = 1.52 K). We can track the regrowth in the concentration of each diborane isotopolog separately, which means we can extract rate constants for the kinetics of recombination for each isotopolog. Assuming the recombination process is diffusion-controlled, we can use the fitted rate constants to look for kinetic isotope effects in the recombination reaction. We use these measurements to distinguish between two potential diffusion mechanisms, activated thermal hopping and quantum tunneling. This project is still ongoing, and the most recent results and analysis will be presented.

[a] M. P. Irion and K.-L. Kompa, *J. Photochem.* **32**, 139 (1986).