

Hydrogen on CVD Diamond and Si Surfaces: Tunable IR Laser Induced Non-Thermal Desorption

Z. Liu^{1,3}, X. Lu¹, J. Davidson², P. I. Cohen³, L. C. Feldman¹, and N. H. Tolk¹

¹Department of Physics and Astronomy, Vanderbilt University, USA

²Department of Electrical and Computer Engineering, Vanderbilt University, USA

³Department of Electrical and Computer Engineering, University of Minnesota, USA

Recent experiments using the Vanderbilt Free-Electron Laser (FEL) have demonstrated that tuned IR radiation can provide wavelength and polarization selective desorption of H₂ at room temperature in the H/Si(111) [1] and in the H/polycrystalline-diamond systems as shown in Figures 1 and 2. The data show strong wavelength and polarization dependence, and also quadratic power dependence, indicating that the effect is non-thermal, and that the desorption mechanism is site selective. These experimental findings are unexpected and unprecedented.

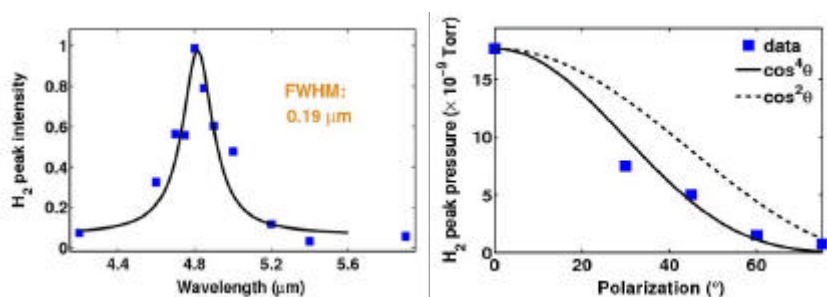


Figure 1. Hydrogen on Si(111) Wavelength Dependence (left) and $\cos^4\theta$ polarization dependence (right).

In the diamond case, we have measured the vibrational modes of C-H stretch bonds on various diamond films. In Fig. 2, the graph on the left shows the FTIR absorbance measurements in the range of 2500-3500 cm⁻¹ performed on an intrinsic CVD diamond film. The middle figure shows the measured desorption of H₂ for a number of wavelengths. The graph in Fig. 2 on the right, clearly demonstrates the broadened wavelength dependence of the hydrogen desorbed from the surface, where the broadening arises from the contribution of multiple lines. The deconvolution graph on the left in Fig. 2, shows 4 peaks within the well-known C-H stretching band (2780-3100 cm⁻¹). We propose that the peaks arise from absorption by the vibrational modes of the C-H_x bonds on different diamond crystal surfaces. Experiments on single crystal diamond samples are presently underway.