



low temperatures, because charge carriers cannot be thermally excited across the bandgap). Further proof was obtained from the presence of significant hysteresis in the structure/pressure relationship. On reducing the applied pressure below 270 GPa, a back transformation to molecular hydrogen takes place at about 200 GPa.

Previous DAC experiments have been carried out at low temperatures (~100 K) to mitigate the hydrogen diffusing into and ultimately destroying the diamonds. The current experiments were performed

at room temperature (295 K) by covering the diamond culets with diffusion barriers consisting of ultrathin layers of Cu, Au, or alumina. These semitransparent layers also enabled structural changes in the hydrogen to be studied using optical techniques, and Raman spectroscopy confirmed that molecular hydrogen becomes opaque and conducting under pressure and that it ultimately transforms into a monatomic liquid. Troyan and Eremets also noted that new Raman bands appeared in the 220–270 GPa range, which

suggests either that the hydrogen retains its Phase I structure until it transforms to a metallic monatomic liquid state, or that it transitions to another phase at 220 GPa.

“Our results on the transformation of normal molecular hydrogen at room temperature to a conductive and metallic state,” said the researchers, “open the door to more comprehensive studies of metallic hydrogen, and further understanding of hydrogen’s phase diagram.”

**Rich Louie**

### Bio Focus

#### High-resolution mapping of soft surface chemistry achieved

Noncovalent interactions between soft materials in solution are an essential component of processes such as biodetection and catalysis, and for the development of technologies including microfabricated devices. Despite this, imaging surface interactions remains highly challenging. One recently developed strategy has used the distribution of fluorescent molecular probes on a surface to build a picture of relative changes in chemical topography. In the November 1, 2011 issue of *Nature Communications* (DOI: 10.1038/ncomms1530), R. Walder and colleagues from the University of

Colorado have taken this approach a step further to produce high-resolution maps of the noncovalent chemistry of soft surfaces, using data from the whole surface trajectory of absorbed molecules.

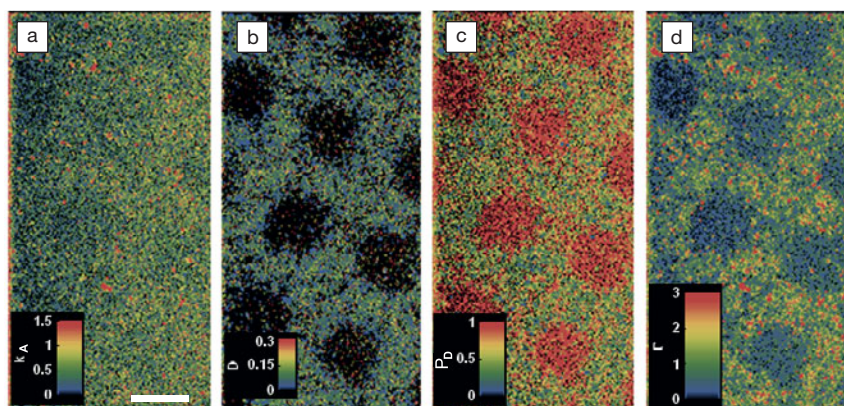
This work uses self-assembled monolayers of trimethylsilane on fused silica as substrates, as these hydrophobic surfaces can be easily micropatterned with hydrophilic regions by exposure to UV light through a suitable mask. Fatty acid molecules that were labeled with the boron-dipyrromethene (BODIPY) fluorophore were chosen as suitable probes, and were applied to the surface in a dilute solution. Each absorbed molecule could then be distinguished using total internal reflection fluorescence microscopy. By taking a series of these snap-

shots over a period of several minutes, the individual trajectories of the probe molecules over the surface could be tracked. A high throughput analysis of these time-resolved images then allowed real dynamic parameters such as absorption rate, diffusion coefficient, and surface occupancy at each surface pixel to be extracted, and maps of the variation of each parameter to be produced (see Figure).

Each of these maps was able to clearly resolve grids of 10  $\mu\text{m}$  hydrophilic squares where affinity with the fatty acid is much lower than on hydrophobic areas. Further, calibration measurements on a series of homogeneous surfaces with different hydrophobicity demonstrated that single-molecule interactions can be used to probe local hydrophobicity quantitatively on an absolute scale.

The team dubs this new imaging technique “mapping using accumulated probe trajectories” or MAPT and, like other molecular probe methods, its resolution is not diffraction limited. While 125-nm features were resolved in this demonstration, its limits are closely tied to the specific interaction between the probe molecule and the surface. Through appropriate choice of probe molecule, it should be possible to extend the technique beyond hydrophobic interactions to mapping variation in surface reaction rates or conformational changes in surface proteins.

**Tobias Lockwood**



Mapping using accumulated probe trajectory (MAPT) images of (a) adsorption rate,  $k_A$  ( $10^{13} \mu\text{m}^{-2}\text{s}^{-1}\text{M}^{-1}$ ) (scale bar is 10  $\mu\text{m}$ ); (b) average diffusion coefficient,  $D$  ( $\mu\text{m}^2/\text{s}$ ); (c) desorption probability per 400 ms,  $P_D$ ; and (d) surface coverage/occupancy,  $\Gamma$  ( $10^{13} \mu\text{m}^{-2}\text{s}^{-1}\text{M}^{-1}$ ) on a photopatterned trimethylsilane surface. Reproduced with permission from *Nat. Commun.* 2:515, DOI: 10.1038/ncomms1530. © 2011 Macmillan Publishers Ltd.