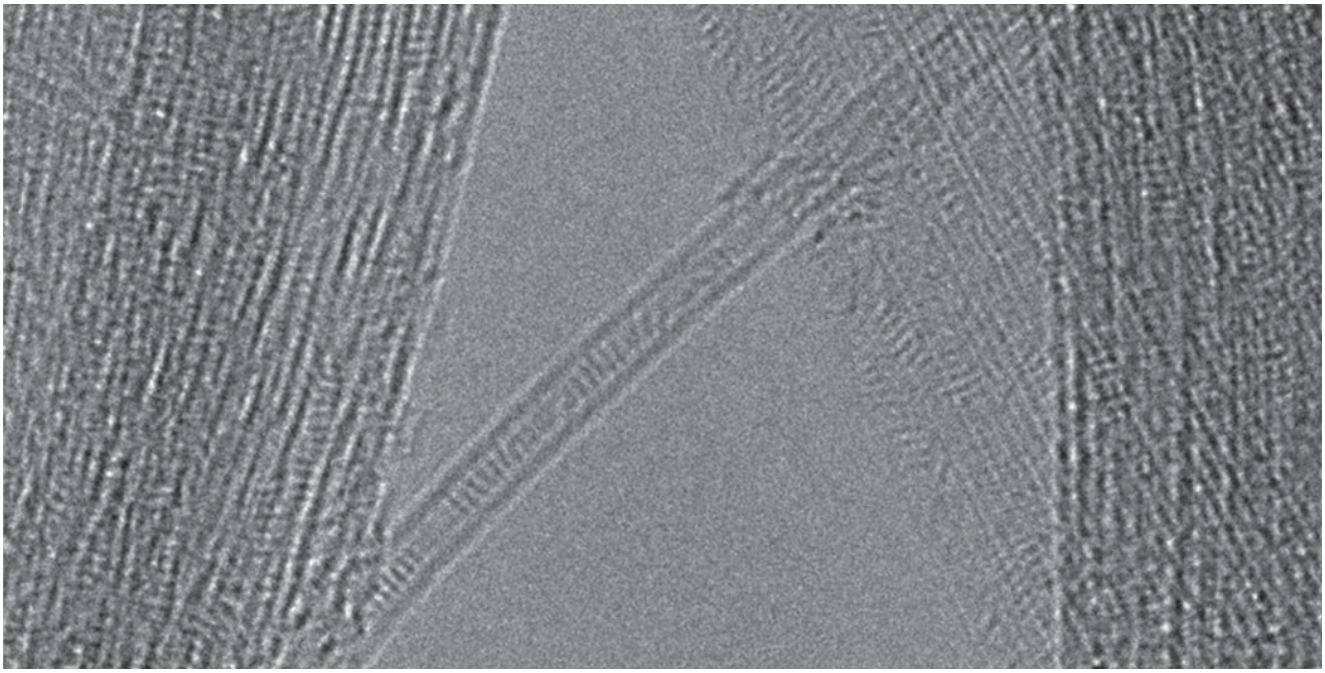

Figure 1. AC-HRTEM image of deuterated coronene molecules inside SWNT (the molecules are seen in their side views). Moreover the image demonstrates an excellent filling rate.

Extending lifetime of organic molecules

Isotope substitution to enhance stability of organic molecules under the electron beam

September 10th, 2014 - **Due to the instability of C–H bonds in the electron beam, atomic-resolution imaging of individual organic molecules in transmission electron microscopy is very challenging. Isotope exchange of deuterium for hydrogene significantly enhances the stability of organic molecules under the electron beam as the higher atomic weight of deuterium simultaneously decreases the amount of energy transferred from the electron beam to the atom, and increases the barriers for atom ejection.**

Research in the field of low-voltage electron microscopy includes the development of new instruments, advancing the imaging theory and investigation of new strategies for the reduction of radiation damage to sensitive materials such as organic molecules composed of carbon (C) and hydrogen (H) atoms. The school of Chemistry together with the Nottingham Nanotechnology & Nanoscience Centre, University of Nottingham and the Group of Electron Microscopy for Materials Science, Ulm University now report their effort directed toward imaging the radiation-sensitive molecule coronene. They have successfully applied two effective approaches: 1. The first approach is already well established; the molecules are placed inside single-walled carbon nanotubes (SWNTs), which allows a strong reduction of ionization and knock-on effects, and suppression of molecular motions. [1-7] 2. The second approach is a new one, shown in this recent paper, where the successful exchange of hydrogen by deuterium has been reported. As a matter of fact, although lower accelerating voltages are used and molecules are encapsulated in SWNT, radiation damage, processes can still not be completely avoided for weakly bonded atoms, and especially light atoms such as hydrogen. The researchers have now shown that the interaction of C-H bonds in organic molecules with the e-beam of the microscope that is followed by displacement of hydrogen atoms, can be effectively reduced by isotopic substitution [†], a process different from previous studies. In this new paper, the science team demonstrated theoretically and proved experimentally that exchanging all hydrogen atoms within molecules with deuterium isotope, and therefore doubling the atomic weight of the lightest atoms in the structure, leads to a two-fold increase in the stability of organic molecules in the e-beam. With this result, the authors provide a simple and elegant solution to the seemingly insurmountable challenge of imaging individual molecules containing H in the electron microscope. It is particularly interesting that isotopic substitution has no effect on the molecular structure so that this method can be applied to image organic matter with higher resolution in LV-AC-TEM.

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