($^{13}C^{18}O$) can be differentiated from the peak positions of IETS. The Ag(110) spectrum was considered as a reference to all other vibrational peaks. The dc sample bias voltage was ramped from 180 to 280 mV in each scan. Sharp peaks were observed at 236 and 224 meV, respectively for Fe($^{12}C^{16}O$) and Fe($^{13}C^{18}O$) which correspond to C–O stretching. The observed isotope shift between Fe($^{12}C^{16}O$) and Fe($^{13}C^{18}O$) is 12 meV, which matches closely with other calculated and experimental values. For Fe($^{12}C^{16}O$)$_2$ and Fe($^{13}C^{18}O$)$_2$ peaks were observed at 234 and 220 meV, respectively. The product of Fe($^{12}C^{16}O$) ($^{13}C^{18}O$) consists of mixed isotopes. The IETS was recorded separately over $^{12}C^{16}O$ and $^{13}C^{18}O$ and peaks were observed at 235 and 223 meV. The observed isotope shift is 12 meV, which is the same as in the previous case.

Comparison of the corresponding activation energy of desorption values indicates that CO can form stronger bonds with an Fe atom compared to the Ag surface or tip. It was also observed that due to the very low temperature of the study there was no bond formation between an Fe atom and a CO molecule in spite of their close presence as shown by the STM topographical images (Figure 1 *a*). The STM tip plays a very important role in the bond formation between an Fe atom and a CO molecule even at very low temperatures.

In addition to the manipulation of atoms and molecules by STM, atomic manipulation can be done by other scanning probe microscopes. A modified Scanning Force Microscope (SFM) has been used for manipulation of various atoms and molecules on various substrates (mica, silicon, graphite, etc.)[8,9] in a controlled manner. This instrument is called a Nano Manipulator. A hand-held force stylus is interfaced with the scanning tip of the microscope. When the microscope is switched to the manipulating mode, the scanning tip moves according to the motion of the hand-held stylus, thus enabling controlled manipulation of the sample. The manipulation force, speed and manipulation direction can be controlled by the user. After manipulation, the microscope can be switched back to the imaging mode to view the manipulation. This cycle can be repeated as desired. The hand-held stylus is connected to the scanning tip by an integrated force feedback loop. During manipulation, several parameters (modifying force, lateral force, topography) are recorded simultaneously. This Nano Manipulator has been used in the manipulation of tobacco mosaic virus[8] and carbon nanotubes[9] and other biological and nonbiological materials.

The STM junction behaves as a reactor of atomic dimension in which tunnelling electrons and the electric field are probably responsible in overcoming the energetic barriers between the stable bonding sites of CO on the surface, tip and the Fe atom. Lee and Ho have done a remarkable job by performing one of the simplest chemical transformations of binding a diatomic molecule to an atom using the STM. The scientific community, especially chemists hope that using the STM more complicated chemical reactions can be performed at the atomic and molecular levels in the future.

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Random selections

High pressure research

‘Hydrogen at high pressure’
E. G. Maksimov and Yu. I. Shilov
Physics – Uspekhi, 1999, **42**, 1121–1138

Nearly 80 years ago, Wigner and Huntington predicted on theoretical basis that hydrogen that solidifies into a molecular insulating phase would transform into a monatomic metallic phase at around 25 GPa (1 bar = 10^5 Pa). This transition pressure got upgraded by further calculations by others to a wide range up to 1500 GPa.

Experiments in the late eighties and nineties showed that the molecular crystalline phase exhibits a rich variety of unusual properties as a result of formation of several anisotropic crystalline transforms (see review by H. K. Mao and R. J. Hemley, *Rev. Mod. Phys.*, 1994, **66**, 671). The phase diagrams of isotopically pure hydrogen and deuterium (H_2 and D_2) have been established on the basis of diffraction data and spectroscopy of optical vibrations of their solids.

Theoretical studies in the seventies led to the prediction of Hi-T_c superconducting behaviour of hydrogen in the metallic phase with a T_c around 200 K. The insulator–metal transition reportedly observed by experimental groups is shrouded with debate and controversy. The discussions cover a wide variety of opinions – from (i) reliability of experimental facts themselves to (ii) possibility of metallic behaviour in the molecular phase itself instead of need to go through a molecular to atomic phase of hydrogen. The story of Hi-T_c in the metallic phase is more complex and at the same time interesting.

The article cited here provides a comprehensive review of this fascinating subject.

‘Shock-induced transformation of liquid deuterium into a metallic fluid’
P. M. Celliers, G. W. Collins, L. B. Da Silva, D. M. Gold, R. Gauble, R. J. Wallance, M. E. Foord and B. A. Hammel
Phys. Rev. Lett., 2000, **84**, 5564–5567

The article by Celliers *et al.* deals with experimental measurements of laser-driven shock waves in liquid deuterium, held at 20 K. The shock velocity and optical reflectance have shown a continuous increase in the reflectance from less than 10% to a saturation value around 50%. The authors conclude that this increase is indicative of the transition of the liquid to a conducting metallic phase. They also state that ‘we find no evidence of a discontinuous behaviour of reflectance as a function of shock velocity such as might be expected if the metallization occurred through a first order phase transition’, as has been recently predicted by Monte Carlo simulations.

From the archives

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Dr M. O. Forster and the Indian Institute of Science

There is a basis of truth in the philosopher’s exclamation—‘Blessed is the country which has no history!’. During the ten years of Dr Forster’s Directorship the Indian Institute of Science has pursued its peaceful way. There have been no students’ strikes or political troubles, and a visitor to the annual gymkhana prize-giving sees nothing but happy faces and generous camaraderie. Some 400 students, including those at present in residence, have passed through the Institute during these ten years. It is no small thing that these young men go out into the world, most of them to fill responsible appointments, all imbued with sane and helpful ideals. When all is said it is probably for this that Dr Forster’s name will be remembered with honour and affection. . . .

. . . there is much of obvious progress to record. The greatest advance has been in Department of Electrical Technology, mainly owing to the zeal and initiative of Prof. Catterson-Smith. Wireless laboratories have been equipped and a high tension laboratory and transformer room have been provided, as well as a direction-finding hut, new rooms for battery and charging equipment and a new drawing office.

The number of students has increased from 15 to 53 and the members of the staff from 3 to 8.

The Department of Biochemistry has also developed, the number of students having increased from 16 to 31. A pot-culture house, animal house, insectory and micro-analytical laboratory are among the extensions to the equipment of the Department.

The Departments of General and Organic Chemistry still retain their supremacy in numbers, the students having increased from 52 to 58 and the staff from 4 to 8. Extensions in building and equipment have also taken place.

Through the generosity of Sir Dorab Tata, a Students’ Gymkhana Club House has come into being and is the centre of the social life of the Institute.

All these things, by whomsoever originated, demand for their successful carrying out constant attention and support from the Director. . . .

. . . As his own personal contribution to the scientific work of the Institute must be specially mentioned Dr Forster’s editorship of the *Journal of the Indian Institute of Science*. 165 parts of the Journal have been published during his term of office, each of which he has edited with meticulous care. In this way he has kept close watch over all the scientific work turned out from the laboratories, and has been able to impress his own high standards of excellence upon staff and students alike. At the close of his tenure of office he has lent his support to the new journal *Current Science* which, while appealing to the scientific public of the whole of India, has its birthplace and headquarters at the Institute.

In brief then we may say that Dr Forster hands over to his successor, Sir C. V. Raman, an institution full of life and possibilities, in good status, socially, scientifically and financially. The foundations have been well and truly laid, what will the superstructure be?