



Figure 1. *Bathynomus giganteus*. **a**, Dorsal view; and **b**, ventral view.

common in deep-sea organisms. But this isopod which occurred at about 300 ft still

retains gigantism. There was no chance of drifting of this animal from the deep

sea, as the specimen was live when collected. The occurrence of *B. giganteus* in neritic waters attaches some importance regarding its distribution.

This rare isopod specimen is displayed in the reference museum of the Fisheries College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Thoothukkudi.

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NEWS

MEETING REPORT

Cold fusion*

In the Tenth International Conference on Cold fusion in the ICCF series, about hundred papers were presented, mostly from USA, Italy, Russia, China and Japan. All papers are put up on the website of the cold fusion community, namely www.lenr-canr.org.

The claims of Fleischmann and Pons made in 1989, that they had experimentally observed large amounts of 'excess heat' during the electrolysis of LiOD with a Pd cathode, and that this was due to (d,d) fusion reactions occurring within

the Pd cathode, was dismissed by the mainstream scientific community, as the results could not be replicated by most groups. Fleischmann had speculated that two deuterons were fusing to yield He-4, but without the accompanying 23.8 Mev gamma rays! A number of researchers around the world, inclusive of some groups from the Bhabha Atomic Research Centre, Mumbai did, however, report finding evidence of fusion reactions, namely detection of neutrons and tritium. I had summarized the then status of the field in a review paper published in *Current Science* (1991, **60**, 617).

During the first few years of the history of cold fusion, the radiationless He-

4-producing mode of fusion was the most widely accepted model of the phenomenon of 'anomalous excess heat'. Experimentalists having expertise in quadrupole mass spectrometry have since reported measuring the production of He-4 during electrolysis. Nobel Laureate Julian Schwinger, Hagelstein and others have theorized how it is indeed possible for the d + d compound nucleus to de-excite by releasing the 23.8 Mev of nuclear energy directly to the lattice as phonons.

But most physicists felt that there were far too many 'puzzles' which were at odds with the existing paradigm and understanding of nuclear reactions, and therefore in all probability the cold fusion

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phenomenon is not real! The report of the committee appointed by the US Department of Energy issued in November 1989 in fact came to precisely this conclusion, and served as the 'official obituary' to the field.

During the last fifteen years, however, the field has evolved into an even more intriguing phenomenon, implying immense challenges to the established and accepted paradigms of nuclear science. For those who are willing to re-examine the fresh and compelling evidence for the occurrence of nuclear reactions at room temperature, the website www.lenr-canr.org catalogues over 3000 papers in the field. Edmund Storms has recently (February 2003) written an excellent status report on the subject entitled 'A student's guide to cold fusion', available in the above website. A new peer-reviewed electronic journal, *Condensed Matter Nuclear Science* (see <http://cmns.mit.edu>) has just been established.

To recapitulate the events that saw the transformation of the field of 'cold fusion into the emergent new field of condensed matter nuclear science', Randell Mills reported in 1991 that he observes excess heat during the electrolysis of a light water solution of K_2CO_3 using a Ni cathode. At ICCF-5 in Monaco in 1995, there was a live demonstration of the patented 'Patterson power cell', producing roughly 100% of excess power. This cell used as cathode, a packed bed of polystyrene microspheres coated with multilayers of micron-thick coatings of metals such as Cu, Pd and Ni and a light water solution as electrolyte. George Miley, University of Illinois carried out a detailed isotopic analysis of the cathode coatings and compared it with that of the non-electrolysed control beads and found to his surprise the presence of a variety of new elements, some even having isotopic ratios different from their natural abundance values. Miley employed both neutron activation analysis and SIMS. He independently replicated these experiments using fresh, thin-film cathodes and confirmed both excess heat and the transmutation of nickel into a variety of other elements.

Comparison of the atomic masses of the reaction products with that of the cathode material, reveals that some of the nuclear reactions are endothermic, borrowing energy from the lattice to cause nuclear transmutation reactions. This phenomenon has also been observed by John Dash, Portland State University. According to

him, it is probably difficult to find a cathode which does *not* have transmutation products in the near surface layers following electrolysis! Bockris, Texas A & M University reported over a decade ago observing new elements in his Pd cathodes following electrolysis. Over the years, other groups from Russia, Japan and USA have also reported observation of individual new elements, both in electrolysis and in glow-discharge experiments using both D_2 gas as well as H_2 gas. All these experimentalists had taken adequate precautions to rule out the possibility of impurities being the source of the 'new' elements.

To summarize, it has now been established that in CMNS the host metal atoms participate in a variety of nuclear transmutation reactions when deuterium or hydrogen ions are 'jam-packed' into the lattice. In some cases, even four deuterons are squeezed into the nucleus of the host metal atom, raising its charge number by 4 and mass number by 8! In other cases there seems to be evidence of fission-type break-up of the host lattice atoms. Such transmutation reactions occur both in hydrides and deuterides.

However, for such reactions to take place, an appropriate 'nuclear active environment (NAE)' has to be established. Such an environment appears to be created on the surface layers of cathodes during electrolysis. Even on the surface only certain 'hot spots' seem to be doing the trick! Also, creation of a 'flux' of deuterons or protons moving relative to the lattice appears necessary for the initiation of nuclear reactions.

Highlights of some of the papers presented at ICCF-10

Letts and Cravens, reported excellent reproducibility in initiating an excess-heat event in their Pd- D_2O cells using a novel 'laser triggering' technique. They first charge their electrodes according to established procedures and then switch on a secondary Au wire anode to co-deposit gold along with deuterium ions onto the cathode surface. When the cathode turns black, a 661.5 nm laser (ordinary laser pointer) with a spot diameter of 2 mm is focused on the cathode. This leads to an exothermic excursion yielding excess powers of 5 to 30 times the 30 mW laser power input to the cell. Turning off the laser leads to decline in the excess power effect, although the power level does not always return to the baseline. Letts repor-

ted that the laser effect depends on the thickness of the gold co-deposition on the cathode surface, the spatial location of the laser spot and frequency of the laser. During his presentation, Letts gave a live demonstration of the effect by remotely switching on the laser into the electrolytic cell which was operating at their lab in Texas. A remote web-camera view of the cell projected onto the screen showed the red laser radiation shine on the cathode and within minutes the cell temperature shot up. This live demonstration of excess heat production highlights the maturity of the field in contrast to the early days of poor reproducibility.

Others who reported replicating laser-triggering of excess heat were Mike Mckubre, SRI International; Ed Storms and Mitchell Swartz, Boston; Akhito Takahashi, Osaka University and Lipson, Lebedev Institute, Moscow who observed it in a glow-discharge experiment. The 'discovery' of laser-triggering of excess heat is considered as one of the important milestones of this field.

Szpak and his colleagues at San Diego had demonstrated a decade ago, high reproducibility of excess heat production using the technique of electrochemical co-deposition of a thin film of Pd onto a substrate simultaneously with loading deuterium into the coated Pd-film cathode. In their ICCF-10 paper, they projected a video clipping that clearly showed how energy release occurs in an 'explosive manner' at localized 'hot spots' where the NAE is presumably created. The birth and death of hot spots are recorded using an infrared movie camera, while the mini explosions are detected by a piezoelectric detector which also served as the substrate onto which the thin Pd film was deposited.

At ICCF-7 in Vancouver, Les Case had reported observing 'excess heat' during the high-temperature absorption of D_2 gas by a commercial carbon-based catalyst containing a small amount of Pd. At ICCF-10, Case presented his latest results with a new catalyst containing 0.1% Pd in carbon. Mckubre had earlier reported measuring both excess heat and helium production during D_2 absorption/desorption by a Pd-loaded catalyst at high temperatures.

Li, Tsingua University, Beijing reported on his team's attempts to establish self-sustaining conditions using a simple gas-loading approach. Basically, his device consists of a long glass tube which is divided into two compartments by a multi-layer Pd foil stack (0.1 mm thick). D_2 gas

is maintained at a pressure of 1 atm on one side, while the other side is kept evacuated causing flow of D₂ gas across the Pd foil stack. The Pd temperature is adjusted using an external electrical heater. Li reported measuring 6 W of excess heat over a duration of 9 h, with the experiment having been replicated six times.

Li and his collaborators have found that in Pd there is a resonant temperature T_r just above which both D₂ flow-rate and heat-conduction rate drop sharply, leading to a negative feedback mechanism. Li reported that this causes a heat 'ignition wave' to flow from the periphery towards the centre of the Pd foil, leading to the prospects of obtaining self-sustaining conditions.

The paper titled 'Low energy nuclear transmutation in condensed matter induced by D₂ gas permeation through Pd complexes' by Iwamura *et al.*, Mitsubishi Heavy Industries was considered as one of the most important papers of the Boston meeting. The experimental set-up is similar to that used by Li *et al.* described above. In the present experiments, the Pd complex comprised of a multilayer, thin film stack of Pd and CaO sandwiched between a thin Pd film in the front and bulk Pd foil substrate at the back. On the thin Pd film in the front side, Cs ions are implanted either by Cs-ion injection or electrochemical coating. The Cs-added

side is exposed to D₂ gas, while the back side is evacuated by a turbomolecular pump. After several days of D₂ gas permeation, elemental analysis and depth profiling of the Pd film is carried out by Time of Flight-Secondary Ion Spectrometry. It is found that ¹³³Cs is transmuted to ¹⁴¹Pr, a Z increase of 4 and A increase by 8! Before permeation there was no detectable Pr in the foil. A similar experiment with Sr ion implantation indicates that ⁸⁸Sr is transmuted to ⁹⁶Mo, again a Z increase of 4 and A increase of 8; clearly a case of four deuterons being absorbed by the Cs or Sr nuclei. Depth profiling indicates, however, that only the top 1 micron layer is active in the transmutation.

Akhito Takahashi's (Osaka University) paper entitled 'Studies on 3D fusion reactions in TiDx under ion beam implantation', reviewed their earlier work in the field. Takahashi also presented the results of the replication of the 'Iwamura effect' at his laboratory.

Hubler, Naval Research Laboratory, USA, is presently attempting to verify the Iwamura effect independently using the sophisticated accelerator mass spectrometer facilities.

Roussetski *et al.*, Lebedev Institute, Moscow reported the measurement of highly energetic charged particles from hydrogen or deuterium-loaded foils made of Ti

or Pd during glow-discharge experiments. ³⁹Cr detectors measured alpha particles in the range of 9 to 16 Mev. Similar high-energy alpha particles were also observed by them when a picosecond laser beam was focused on 30-micron thick TiH₂ or TiD₂ foils. At ICCF-9, this group had reported observing alphas in the 8 to 14 Mev range using dE-E SSB detector from previously loaded Au/Pd/PdO multilayer, thin films mounted in a vacuum chamber during the exothermic desorption phase. Thus, emission of high-energy alphas, irrespective of the foil-loading technique or excitation technique or whether the loading is with hydrogen or deuterium, has been corroborated by different groups.

A noteworthy feature of the Boston meeting was the absence of any paper pertaining to the measurement of neutron yield, indicating the diminished importance of neutrons as a diagnostic tool in the new dispensation of CMNS physics.

The emphasis in the immediate future is clearly the understanding of the characteristics of the NAE and the theoretical basis of the phenomena. There is tremendous scope and challenges for the young researcher who enters the field at this juncture.

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RESEARCH NEWS

Pentacoordinated phosphorus in action

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The recognition that phosphates play a central role in the living world gave rise to extensive kinetic and mechanistic studies on solvolytic reactions of simple phosphoric acid esters as well as biochemical reactions catalyzed by enzymes like phosphatases, ribonucleases, mutases, etc.^{1,2} Nucleophilic displacements (e.g. solvolysis/transesterification) on phosphorus are involved virtually in every aspect of cellular energetics and many aspects of biosynthesis. Two basic pathways for these reactions involving phosphate monoesters are shown in Scheme 1. Variations in the intricate details

of the mechanism are possible depending on the details we are interested in¹ but the focus is on whether the pentacoordinated species (**1**) or monomeric metaphosphate species (**2**) is involved. In contrast to carbon which can form only four stable covalent bonds, phosphorus is able to form five. Hence, while the nucleophilic attack on carbon leads to a transient five-bonded transition state, attack on phosphorus could produce a relatively long-lived pentacovalent intermediate. Numerous *neutral* and a few *monoanionic* pentacoordinated phosphorus compounds have been well

characterized in the small molecule domain^{3,4}. However, it is perceived that dianionic phosphorane intermediates like **1** do not exist as stable species in the gas phase, unless the -2 charge is effectively delocalized^{2,5}. Thus the solvated form of the latter with six water molecules (**3**) is predicted to exist as a TBP species in the gas phase. The metaphosphate (**2**) is stable in the gaseous phase, but not in aqueous solutions. It has been a dream for many biochemists to 'catch' species such as **1** or **2** in true bio-systems and structurally characterize them. This highlight refers