SCIENCE NOTES AND NEWS

Award of Research Degrees

Annamalai University has awarded the Ph.D. Degree in Chemistry to Shri A. Ekambaram for his thesis entitled "Dipole Moments and Absorption Spectra of Some Sulphoxides".

Osmania University has awarded the Ph.D. Degree in Chemistry to Shri Venkatachala Somayajulu Vangala for his thesis entitled "Search for Physiologically Active Compounds Synthesis of Some Condensed Oxazoles".

The 20th Anniversary of the World's First Nuclear Reactor

Leading atomic scientists from several countries have contributed to a Special Number of the *International Atomic Energy Agency Bulletin* to mark the 20th Anniversary of the start-up of the World's First Nuclear Reactor.

The reactor, built in the grounds of Chicago University by a team of scientists under the leadership of Enrico Fermi, went critical on 2 December 1942. After twenty years, there are today more than 50 nuclear power reactors and some 300 research reactors operating or nearing completion in various parts of the world.

The purpose of the Special Number of the *IAEA Bulletin* is to draw attention to the significance of the construction and successful operation of the first atomic "Pile" in the context of the scientific research and experiments that preceded that achievement and the growth of nuclear science and technology that has followed since. Among those who have contributed to this volume are some of the scientists who laid the foundations of nuclear science or have played leading roles in the development of atomic energy applications in their respective countries.

Thus we find in this *Bulletin* specially written articles by Otto Hahn, Samuel K. Allison, Glenn T. Seaborg, Sir John Cockcroft, Dr. Goldschmidt and V. S. Emelyanov.

A popular descriptive account of the first pile, written originally in 1946 by Allardice and Trapnell, has also been reproduced in the *Bulletin*. A short introductory article has been written by Dr. Sigvard Eklund, Director-General of IAEA.

The Special Number of the *Bulletin* is published in five languauges: English, French, German, Russian and Spanish.

Effect of Ultra-High Vacuum on Micro-organisms

The effects created by exposing organisms to a vacuum have long been a subject of interest to biologists. The use of vacuum in storing micro-organisms is an essential part of lyophilization preservation technique. In this method, the organisms are frozen at $-80°$ C. and dehydrated by a vacuum of 10^{-3} mm. mercury. The tubes containing the organisms are sealed off under vacuum and may be stored for several years.

Conflicting views have been expressed regarding the ability of micro-organisms to withstand ultra-high vacuums of the order of 10^{-8} mm mercury or better. Thus Willard *et al.* reported that exposure of micro-organism spores (*Bacillus subtilis*, *Aspergillus niger*, *A. terreus*, and *Penicillium citrium*) to pressures of $1{\cdot}2 \times 10^{-8}$ mm. mercury for periods of time 10 to 30 days would cause their destruction. On the other hand, the work of Porter *et al.* failed to show any effects of vaccum on three types of micro-organisms (*B. subtilis*, *A. fumigatus* and *Mycobacterium smegmatis*) exposed to a vacuum of less than 10^{-9} mm. mercury for 5 days.

To clinch the issue, Morelli *et al.* report their detailed investigations on the effect of ultra-high vacuum on *Bacillus subtilis* var. *niger*. Their results demonstrate that the micro-organism *B. subtilis* will survive exposure to an ultra-high vacuum (10^{-8} mm. mercury) for a period of 35 days. The experiment also shows that ultrasonic vibrations and radiation encountered during seal-off of the apparatus have no significant effect. It will be interesting to study the effect when *B. subtilis* is exposed to a vacuum approaching that encountered in outer space.—(*Nature*, 1962, 196, 106.)

Carotenoids in *Delonix regio* (Gul Mohr) Flower

The distribution of carotenoids in petals and anthers of different flowers has been studied and reported by many investigators. But qualitative and quantitative data on the distribution of carotenoids in different parts of the same flower are not so easily available. H. R. Cama and F. B. Jungalwala in an article contributed to the *Biochemical Journal* (1962, 85, 1) report the results of a detailed study of

carotenoids in different parts of *Delomix regia* flower.

The petals of *D. regia* contain 29 carotenoids. The major pigments identified are: phytoene, phytofluene, β-carotene, γ-carotene, lycopene isomers, rubixanthin, lutein, zeaxanthin, and several epoxy carotenoids. The role of epoxy carotenoids in petals is not known. However, they may be intermediates in the transfer of oxygen and formation of xanthophylls.

The sepals contain 18 carotenoids, the filaments 20 carotenoids, and the anthers 10.

Certain carotenoids are present only in a particular part of *D. regia* flower, *e.g.*, pigment X, δ-carotene and rubixanthin are only found in petals, whereas α-carotene is confined to sepals.

The highest concentrations of total carotenoids are found in the anthers. Of the total carotenoids here, 90% is zeaxanthin. The presence of considerable amounts of specific carotenoids in the anthers of *D. regia* suggests that 'oxygenated' carotenoids may have some role in the reproduction of this plant.—(*Biochem. J.*, 1962, 85, 1.)

A Simple Neutron Source

O. Reifenschweiler and K. Nienhuis of the Philips Laboratories, Eindhoven, describe a neutron source tube which is about the size of an X-ray tube, and is operated in a similar way. Supplied with a direct voltage of 125 kV, this tube is capable of generating neutrons with an energy of 14 MeV. at rates exceeding 10^8 neutrons/sec. The neutrons arise out of a nuclear reaction between tritium and deuterium:

$$^3_1\mathrm{H} + ^2_1\mathrm{H} \quad ^4_2\mathrm{He} + ^1_0n + 17{\cdot}6\ \mathrm{Mev.}$$

The deuterons are produced in a Penning ion source and accelerated up to 125 kV in a single-stage accelerating system. They strike a target consisting of a 1 μm film of titanium which has been evaporated on to a silver base, and which contains tritium. The tube is filled with a deuterium-tritium mixture at a pressure of about 10^{-3} torr; consequently the target is bombarded with tritium ions as well as deuterium ions and in this way its charge of tritium is kept at saturation more or less indefinitely. The pressure inside the tube is adjusted by means of a built-in replenisher containing a large reserve of D-T mixture. The life of the tube has been tested to exceed 1000 hours. The yield of the tube can attain 10^9 neutrons/sec. when it is pulse-operated (minimum duration 5 μs). The article also indicates some typical applications of this compact neutron source. —[*Philips Technical Review*, 1961-62, 23 (11).]

Mariner II—the Venus Probe

The US spacecraft, Mariner II, was launched on August 27, 1962 in the direction of Venus, to make closest approach to the planet (but not land on it), and send back data about the planet's atmosphere, etc. The weight of the spacecraft was 447 lb., and it carried in its payload electronic instruments for six scientific experiments. Four of these began operating on the fourth day of the launch and sent back space data on solar wind, magnetic fields, cosmic rays and ionization. The other two "sensors"—microwave and infra-red radiometers—were scheduled to operate on December 14, 1962 when Mariner II passed closest to Venus.

This was achieved when on December 14, radio contact was again made with Mariner II and coded reports were received for 42 minutes, about both the light and dark sides of Venus. Mariner II was then 36 million miles from the earth but had travelled 182 million miles through space. It has now gone into orbit round the sun.

Reversal of Magnetic Field in Superconducting Thin Films

Experimental evidence for the theory that a magnetic field reverses its direction on passing through a superconducting thin film is announced by the I.B.M. Research Laboratory of Zurich.

In the experiment thin films were evaporated on to the outside surface of a rotating glass substrate to obtain long hollow cylindrical films. These were then removed from the vacuum system and cooled to the temperature of liquid helium. They were then subjected to a magnetic field; the field which penetrated through the films into the interior of the hollow cylinder was detected by a pick-up coil placed inside the superconducting cylinder. The reversal was observed on a cathode-ray tube, which displayed both the signals from inside and outside the cylinder. Below a certain temperature a clear indication of a reversal in the direction of the magnetic field was shown, as a *phase change* between internal and external signals.

These new data would be of great value in the development of high capacity computer information storage and ultrafast switching speeds.

Earth's Convection Currents and Orogenic Processes

According to F. A. Vening Meinesz the forces and stresses working in the earth's crust, which

are parallel to the crust, are caused by the drag exerted on the crust by convection currents in the mantle. Such currents are caused by the cooling of the earth at its surface, which lowers the temperature of the upper mantle layer. This layer thus becomes denser and so the mantle gets unstable. By some secondary phenomenon a convection current is set in motion and this current makes about a half turn. The denser upper mantle layer is then down, and the hotter, and therefore, lighter, layer is up; the mantle stability is thus restored and the current stops. The crustal movements, caused by the mantle currents, are thus also brought to an end and the orogenic period is completed. According to the geological indications such half-turn currents last 50-100 million years.

A long period of several hundreds of million years ensues, during which the upper mantle layer cools again and the lower layer is heated up by the earth's core. A new system of mantle convection currents can again start and a new orogenic period sets in.

In view of the time that tertiary orogenic phenomena have already been going on, we can probably conclude that at present we are living in the second half of an orogenic period; the half-turn currents are no doubt still continuing. This is shown by the seismic activity.

By supposing this explanation of the orogenic processes, we do not assume that the whole earth is cooling, but only that the earth is losing heat by radiation at its surface. It depends on the amount of heat produced in the earth, e.g., by radioactive constituents, whether the earth as a whole is heating or cooling.—(*Proc. Kon. Ded. Akad. V. Wetensch.*, 1962, 55, 327.)

Strength of Bone

The two major components in bone are the ceramic component apatite, and the protein component collagen. The mechanical properties of bone are different from what one would expect from the properties of these components as they are studied in bulk. Thus ceramic materials are characteristically very much stronger in compression than in tension. The compressive strength of porcelain, for example, is about 100,000 lb./sq. in., whereas the tensile strength is only about 6,500 lb./sq. in. Collagen on the other hand, has low elasticity, but can, in certain circumstances, have a very high tensile strength, about, 80,000 lb./sq. in. According to J. D. Currey, in a letter to *Nature*, collagen and apatite form a two-phase combination in bone to produce the mechanical properties shown by it.

It is known that in two-phase materials such as fibreglass, the increased strength is attained because the minute cracks, known as Griffith cracks, in the stiff fibres, which would normally spread under the influence of tensile stresses causing the whole structure to fail, run instead into the flabby matrix which will not transmit the crack but will merely deform.

The essential feature of bone from the mechanical point of view is that the apatite is in the form of very small crystals, of the size 500 Å × 40 Å, embedded in a collagenous matrix, and the Griffith cracks in the elastic apatite do not spread into bigger ones, but run out of the apatite crystals into the collagen, which will deform under their influence, without producing rupture. Thus the combination gives bone a high elasticity in tensile strength of about 15,000 lb./sq. in. and a compression strength of 25,000 lb./sq. in.

This arrangement requires that the apatite and the collagen should be bound fairly firmly together. At the moment it is not certain what forces are binding the two components. It is possible that it may be simple hydrogen bonding or though less likely, the small amount of mucopolysaccharide in bone may be acting as a cement.

According to J. D. Currey, the superiority of bone over most other skeletal materials is probably one of the main foundations of the success of the vertebrates. Invertebrate skeletons usually consist of large crystals of calcium carbonate in which cracks can easily spread.—(*Nature*, 1962, 195, 513.)

Propagation of Microwave Phonons in Germanium

Recent work has shown that there is an appreciable electronic contribution to the shear elastic constant C_{44} in heavily doped *n*-type germanium. The electronic contribution is of the relaxation type; it depends on the redistribution of electron population in the several valleys of the germanium conduction bands when the crystal is strained.

Thus one can anticipate that relaxation dispersion and absorption will be present if the elastic constant is measured in an appropriate frequency range. M. Pomerantz *et al.* report large anelastic absorption associated with the electronic redistribution at a frequency near 10^{10} cycles/sec.

The microwave phonons were generated and detected by spin wave-phonon interactions in thin films of Ni-Fe alloy evaporated onto an end of the germanium specimens. It is possible to generate both longitudinal and transverse phonons by this technique.

Two kinds of germanium specimens (single crystal bars 1/10 inch sq. × ½ inch) were studied, one, "pure", containing less than 10^{14} donors/cm.^{3}, and the other, 'heavily doped", containing more than 10^{19} arsenic donors/cm.^{3}

Phonon propagation was studied in two directions, viz., [110] and [100]. Five types of waves could be studied, three in the [110] specimens involving the elastic constants ½ $(C_{11} + C_{12} + 2C_{44})$, C_{44}, and ½ $(C_{11}-C_{12})$ respectively, and two in the [100] specimens involving the elastic constants C_{11} and C_{44}.

The interesting feature of the results is that, although all of the waves can be propagated in pure germanium, only those waves whose elastic constant does not contain C_{44} can be propagated in heavily doped germanium. This is exactly the prediction of the theory of the electronic contribution to the elastic constants of germanium. The waves whose elastic constant contains C_{44} destroy the degeneracy of the valleys and are attenuated by the electronic relaxation absorption. There is no electronic effect associated with the waves whose elastic constant does not involve C_{44}.—[*Phys. Rew Letters.* 1962, **9** (7).]

Chloroplast Ferredoxin—A New Step in Photosynthesis

In an article contributed to *Nature* (1962, **195**, 537) Prof. D. I. Arnon and Dr. K. Tagawa, of the Universiy of California, report the isolation from spinach leaves of an iron-containing protein, localized in chloroplasts, which plays an important role in the biological production and consumption of hydrogen gas. It is found to be the most electronegative electron carrier ($E_0' = -432$ mV at pH 7·55) in cellular oxidation-reduction reactions. It is also the most reducing constituent which has been isolated so far from photosynthetic apparatus of green plants or photosynthetic bacteria. The properties and photosynthetic action of the chloroplast iron protein are similar to those of ferredoxin, the iron protein isolated earlier this year by Mortenson *et al.* from soil bacteria of the genus *Clostridium*, and also obtained in crystalline form from *C. pasteurianum* by Arnon and Tagawa in their present studies. Hence they have called the spinach iron protein isolate *Chloroplast ferredoxin*. Chloroplast ferredoxin has been found to a large extent functionally interchangeable with the crystalline bacterial ferredoxin. Its redox potential, as mentioned above, is more electronegative than that of *Clostridium* ferredoxin ($E_0' = -417$ mV at pH 7·55).

Chloroplast ferredoxin normally functions in photosynthesis as an electron carrier which transfers electrons released from chlorophyll by light to pyridine nucleotide, which in turn serves as the electron donor for the conversion of carbon dioxide to carbohydrates. Under special experimental conditions, which included the addition of bacterial hydrogenase, the chloroplast ferredoxin was found to be capable of: (*a*) mediating, *in the dark*, a reduction of pyridine nucleotide by a flavoprotein fraction of chloroplasts with hydrogen gas as the donor; (*b*) mediating, *in the light*, a production of hydrogen gas by chloroplasts with ascorbate or cystein as the electron donor; and (*c*) mediating, *in the dark*, the production of hydrogen gas with sodium dithionite as the electron donor.

Ferredoxins as electron carriers function in collaboration with enzymes. It may be that this action is due to its iron atoms undergoing reversible oxidation-reductions. It may be mentioned that spinach ferredoxin shows a relatively high iron content (0·815%) and a ratio of ferredoxin to chlorophyll of 1 : 400.

The particular role of ferredoxin in photosynthesis, namely, that they are carriers that transfer to appropriate enzyme systems the most "reducing" electrons in cellular metabolism, that is, electrons at a potential of −420 mV, has great significance. Such electrons come from either hydrogen gas or 'excited chlorophyll". Hence the importance of the investigations of Arnon and Tagawa lies in their finding that ferredoxin enables chloroplasts to take electrons from hydrogen gas and transfer them to pyridine nucleotide in the absence of light. In other words, hydrogen can perform the function of light in chloroplasts that are enriched in ferredoxin.

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