Is the Occurrence of Cold Nuclear Reactions Widespread Throughout Nature?

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Introduction

The generally accepted idea is that the paper of Fleischmann, Pons, and Hawkins of 1989[1] gave the first evidence that nuclear reactions occur in the cold in a palladium-deuterium (Pd-D) electrolysis system. However, published accounts on elemental change in solids have been around since before the discovery of the nucleus (Rutherford[2]). Thus, the earliest evidence for creation of new elements was that reported for reactions in biological systems. In view of the wave of negative opinion against the 1989 and thereafter work, it is interesting to note a U.S. Army report of 1978[3] which concluded that the evidence for nuclear reactions in biology was strongly positive. Even less well-known is that U.S. government labs in the 1970s[4] experimented with neutron emission arising from the passage of very high currents through wires, conditions under which thermonuclear reactions should not have been occurring. [Editor's Note: See also P. and N. Graneaus' article, pp. 27-28 in this issue of *Infinite Energy*.]

In this paper, facts will be cited as evidence that nuclear reactions occur not only in Pd-D systems but in many parts of Nature. Our present chemical interpretation of natural phenomena—which neglects nuclear activity in the normal ambient temperature world (far less than millions of degrees K)—is incomplete. Though not all the following cited phenomena may turn out to be real—and some are certainly more likely to be than others—this listing is an indication of how wrong may be the present paradigm, which denies low-energy nuclear reactions, reactions "in the cold."

Hydrogen in Palladium

Fleischmann, Pons, and Hawkins[1] observed substantial heat of nuclear reaction magnitude (*cf.* the conclusion of the Army's 1978 report) and a low-level emission of neutrons. Tritium, measured by an indirect method, was also claimed.

The material on D-Pd is summarized in the book by Kozima.[5] However, the production of neutrons by Borghi[39] from a klystron discharge, and other chemical work cited below, and the biological work, preceded the much quoted Fleischmann and Pons work. Further, there is some evidence that others, such as Paneth, Peters, and Tandberg, in the 1920s and 1930s may have observed low-energy nuclear reactions in palladium metal hydride systems—even though the first two authors later rejected their initial nuclear conclusions.[41]

Discussion of systems using H instead of D began in 1989 among electrochemists, for it was seen, experimentally, that the tunneling probabilities for H greatly exceed those for D. The first publication involving H as opposed to D seems to have been that of Mills and Kneizys[6] in 1991.

Enyo and Ohmori[7] reported heat equivalent to four times the input energy using Pd and an aqueous system. Mizuno[8] showed that a large excess of heat from ceramic proton conductors can be obtained, but the reproducibility was poor. R. Oriani at the University of Minnesota later confirmed the Mizuno proton conductor work.[42]

The most remarkable development of H systems has been in the Patterson cell,[9] which involves an array of plastic microspheres, plated with a thin film of Cu, Ni, and Pd. Heat up to 1,000 times the electrical input power has been recorded. The results of testing Patterson cells by the Motorola Corporation also substantiated the so-called "heat-after-death" phenomenon, in which nuclear-scale power generation was seen to persist for days even after input electrolysis power was cut off. This general phenomenon has been seen by Fleischmann and Pons[43] and by Mizuno.[22]

The Discovery of He-4 in Electrolysis of LiOD in D_2O

When D_2 is evolved from D-Pd on Pd, one of the possible nuclear products is He-4. This was first reported present in the evolved D_2 by Melvin Miles *et al.*[31] in 1991. However, doubts were expressed because the system first used was of glass and diffusion (from the outside air) of He-4 through glass was suspected. Miles *et al.* remain firm in their opinion that helium evolution roughly commensurate with excess heat production has been demonstrated then and subsequently.[32,34,44]

In 1992, Chien *et al.*[30] discovered He-4 in Pd after prolonged electrolysis (Pd-LiOD-D_2O). Pd maintained for long periods in air contains about 10^9 atoms cc^{-1} of He-4. After electrolysis, the amounts were 10^{10} - 10^{11} atoms cc^{-1}. The experiments eliminated the possibility that the extra He-4 is from the air.

The seminal work of Arata and Zhang[45] with the Pd-D system, finding massive nuclear scale excess energy (up to 500 MJ/mol) as well as He-4 and He-3 in anomalous (non-natural) ratio, lend considerable support to the earlier helium detections.

Alchemical Experiments at Texas A&M

Joseph Champion, an electronics technician with experience in work related to the electrochemical extraction of metals from sea water, approached the author Bockris at Texas A&M University in 1992 with claims to have used a mechanical impact method to produce Au from Pb and Hg salts. His method was examined, the practical work being done by Bhardwaj and Lin.[11] The starting material contained Hg, Pb, S, graphite powder, and KNO_3. Ignition of this mixture causes a mild explosion. After two to three days, the resulting mixture was examined by several methods and by four independent analytical agencies. Some results from one of four successful experiments are in Table 1. Au at up to 300 ppm (Table 1) was detected in the mixture (original mixture <1ppm). The method gave good results only sporadically. A β radiation activity was discovered in the product.[28] The work was curtailed in March 1993 because of difficulties in funding. Restrictions due to the sponsor's wish for confidentiality prevented publication of the Texas A&M results until 1996.[11]

A reproduction of the production of noble metals by Champion's impact method has been reported by Cau.[12] Correspondingly, Filiminov and Kobets[13] have shown that an impact method can be used to cause change in the isotopic abundance in Cs, *i.e.*, a nuclear reaction is made to occur.

This work of April 1992 at Texas A&M (see Table 1) is noteworthy because it formed the beginning of the era of scientific work on *transmutation* of metals in the cold, now the subject of sessions held in recent years at meetings of the American Nuclear Society and the American Physical Society.

Champion's low level of scientific qualification (and checkered career) prevented credit being given to him. Along with the Italian physicist, Roberto Monti,[14] he was the pioneer (in 1992)

Table 1. Champion Impact Method Tested by R. Bhardwaj and G. Lin at Texas A&M University (1992). Results in p.p.m.

Sample	Ru	Rh	Pd	Ag	Ir	Pt	Au	Method
NT-2A	<1	1,8	1,8	436	0,03	-	986	0,3g sample and Na_2O_2 fusion - dilution and ICP-MS
	-	0,03	2,7	-	-	0,18	848 [719]	10g sample - fire assay - Pb collection. Pressure dissolution of prill - ICP-MS
	0,07	1,4	1,1	-	<0,1	0,2	471*	1g sample and Na_2O_2 fusion - Dowex 50Wx8 column separation (3x); dilution - ICP-MS
	-	0,13	2,2	-	0,12	-	830 [642] [824]	1g sample and Na_2O_2 fusion - Te/$SnCl_2$ precipitation and ICP-MS
NT-2B	<1	0,85	0,01	493	0,08	<0,1	15,8	0,3g sample and Na_2O_2 fusion - dilution - ICP-MS
	-	0,02	0,34	-	-	0,03	8,4	10g sample - fire assay - Pb collection - pressure dissolution of prill - ICP-MS
	<0,1	0,78	<0,1	-	<0,1	<0,1	<1*	1g sample and Na_2O_2 fusion - Dowex 50Wx8 column separation (3x); dilution - ICP-MS
		<0,5	0,34	-	0,09	<0,1	0,5	1g sample Na_2O_2 fusion - Te/$SnCl_2$ precipitation and ICP-MS

of helping to break through a thick wall of prejudice against the occurrence of metal-to-metal transmutation in the cold.

The Results of Arcing in Gases and Liquids

Little known experiments on the effect of sparking in octane-air mixture were carried out in 1974 by Speri and Zorzi[15] though not published until 1989.[24] The heat produced by chemical combustion of octane-air was measured. Then, three extra sparking units were added to the system and a significant increase in heat evolution was observed over that calculated from the chemical reaction. The authors show calculations on the assumption that the D naturally present undergoes fusion to form He-4, whereupon heat would be evolved. If one naturally occurring deuteron per thousand present reacts, they achieve numerical agreement with their results.

Yull Brown[16] added D_2O to an aqueous alkaline solution and ignited the gaseous H_2-HD-D_2O mixture resulting from electrolysis. He claimed a flame reaching 6000°C. Tungsten was easily melted and sublimed. Tritium was found in the water condensate. However, further observations of the so-called "Brown's gas" at NERL in 1998 cast doubt on whether any anomalous "sublimation" of tungsten really does occur in any Brown's gas experiments (though the NERL tests were not done with D_2O). More likely, the tungsten sublimation is mere oxidation of tungsten—the same process that occurs with a normal stoichiometric oxy-hydrogen torch, as demonstrated at NERL.

Roberto Monti stressed an "alpha particle structure" of the nucleus and on this basis predicted transmutation in the cold. He presented his ideas in correspondence to Bockris in 1990, and subsequently described an unpublished experiment in which Fe had been observed to be formed from carbon if an arc was struck between two pieces of pure carbon immersed in water.

This experiment was performed by R. Sundaresan[17] in Bockris' laboratory in 1993 with meticulous attention to impurities in the spectroscopically pure carbon, and in the water and ambient air. A 10 amp current between two spectroscopically pure carbon rods, in highly purified water, passed for ten hours, produced small quantities of Fe. If O_2 were excluded, no Fe was formed. The following nuclear reaction (suggested by G. Lin) is quantitatively consistent with the observation:

$$2\ {}_6C^{12} + 2\ {}_8O^{18} \rightarrow {}_{26}Fe^{56} + {}_2He^4$$

Many Metals from H and D in Pd

The late Kevin Wolf,[18] at Texas A&M University, found a number of radioactive elements in Pd after prolonged electrolysis of LiOD in D_2O. The discovery was made in September of 1992 (*cf.* The Champion impact experiments at Texas A&M in April, 1992). Wolf had rejected the finding of tritium at Texas A&M in 1989 in spite of 1990 work in which he had reported finding tritium[19] in his own experiment. Thus, his clear findings of the product of transmutation was a result inconsistent with his stance in respect to tritium. He chose not to publish the transmutation evidence nor to present the work at meetings such as ICCF-4 in Hawaii, though invited to do so. [Editor's Note: See the account of this astonishing episode in *Infinite Energy*, No. 2, 1995, "Alchemy Nightmare."]

Wolf's transmutation work was finally published by Tom Passell,[18] a project leader in the institution (EPRI) which had paid for this cold fusion research work. The first formal publication of Wolf's work on tritium was in 1996.[19]

However, in 1995, Bockris and Minevski[20] published the results of new materials they had found in Pd after electrolysis for three weeks. Among the new metals identified by EDS were Al, Mg, Cl, Ca, and Fe. Bockris and Minevski made parallel studies of the solution by ICP and found there certain impurities (*e.g.*, Pt, Si and Zn) which did indeed show up in the electrode surface and were detected by XPS (which has a penetration depth of ~30 Å).

The technique used in the Bockris and Minevski work, of measuring surface impurities (by XPS) and then impurities at various depths (by EDS), overcomes the criticism that the new materials come from the solution. This work, recorded from the 1995 thesis of Zoran Minevski,[35] preceded the work of Miley *et al.*,[21] and

Mizuno *et al.*,[22] who repeated experiments using isotopic abundance ratios to distinguish new material. However, they did not do the double analysis of the surface and bulk; nor did they compare with impurities in solution. They were dependent on the (sometimes ambiguous) isotope ratio studies to prove the transmutation.

Diminution of Radioactivity

There have been several claims to be able to do this. The first came from Yull Brown[36] and was tested in front of DOE engineers who are reported to have said that describing what they had seen in these reports could threaten their employment by DOE. Hence, they would be forced to report a null finding. Brown's method was to play the intense flame from the so-called "Brown's Gas" (a hydrogen-oxygen mixture, probably containing HD) on a sample of radioactive wastes. Diminution of the radioactivity by about 80% in fifteen minutes was claimed. Tests were made to ensure that no material from the container had escaped to the laboratory, or that the original radioactivity was not blocked inside large particles.

Stan Gleason,[37] working with colleagues calling themselves jointly The Cincinnati Group, subjected a solution of $Th(NO_3)$ to AC electrolysis and claimed diminution of the radioactivity of the solution by some 90% in some hours. A highly anomalous ratio of copper isotope abundances in the *visible* fragment of copper *produced* in the cell was observed. Fox[38] reported similar radioactivity diminution results and examined deposits formed on the electrodes and in the cell to ensure that the original $Th(NO_3)$ was not contained there. F. Celani[49] in Italy has provided partial confirmation of The Cincinnati Group's work using one of that group's tests cells, which are being marketed as a demonstration cell—unfortunately with few purchasers. This is due, no doubt, to the very heretical nature of the work as well as the need for good nuclear measurements that are generally not available to many prospective researchers.

Detailed descriptions of these efforts have been published in *Infinite Energy* magazine and the *Journal of New Energy*, but no further reports can be given on these results because of the paucity of details published, perhaps due to patent concerns. However, as of June 1999,[33] studies of the effect Brown's gas are being carried out in the Nuclear Facility at Chalk River in Canada, and at the University of Ottawa and in Ireland under European Commission funding. There have also been tests of Clean Energy Technologies, Inc. (CETI) radioactivity remediation cells at a DOE contractor's laboratory in the state of Washington. Results of these tests are said to give positive indications of low-energy transmutation, but details are currently not available.

Perhaps the most provocative development in the field of Low-Energy Nuclear Reactions is the award of a DOE contract in May 1999 to the Low-energy Nuclear Reactions group of Professor George Miley at the University of Illinois, Champaign-Urbana (see *Infinite Energy*, No. 26, p. 43). The purpose of this peer-reviewed award is to demonstrate the electrolytic "cold fissioning" of radioactive elements such as uranium and thorium, precisely what Prof. Miley as well as CETI have already demonstrated independently to their mutual satisfaction. Naturally, political and scientific opposition to this award for heretical investigation has already arisen, a controversy that has now boiled over into the general scientific press (see *Science*, July 23, 1999, 505-506 and an editorial in this issue, p. 4).

Nuclear Reaction in Chemical Systems

It has been seen that early claims about nuclear effects in chemical reactions were made by Speri and Zorzi in 1978[15] and, much earlier, in biological systems. [3, 10, 25]

Some surprising work has been carried out by L. C. Case[23] which seems to establish cold nuclear reactions in chemistry in a very desirable way. He confined D_2 over Pd-doped carbon at modest pressures and $130 < T < 275°C$. 100 ppm He-4 was detected in the resulting gas. This helium-generation in what Case calls "catalytic fusion" has now been confirmed in multiple studies performed at SRI International (see *Infinite Energy*, No. 26, p. 16). Independent efforts by Saturna Technologies, Inc. and at NERL are under way to further confirm and develop the Case studies. Case himself is aiming to produce a self-sustaining catalytic heat generator (self-heating with no input power) that will also produce helium.

Remarkable results (which have been verified by three independent German laboratories) have been obtained by Mündt, as reported by Petermann.[40] Mündt has measured the input and output energy in the anaerobic combustion of trash. The necessary initial heat input is provided by household light bulbs. The vessel is built to withstand pressures formed by the products of the reactions occurring among the trash in the absence of O_2, but as a result of heating. The thermal output is 2.7 times the input. As with the Champion and Wolf experiments, radioactivity was detected. The development of a magnetic field is also reported.

Biotransmutation

The anomalous formation of new nuclei has received quantitative examination since 1799 when Vauquelin[24] observed a large quantity of lime (CaO) in the excreta of chickens. He fed the chickens only on oats, measuring the Ca in the oats and then in the chicken excreta and eggs. He found twelve times more Ca in the chickens' output compared with the amount of the input. In 1960, Professor Baranger[24] examined germinating seeds for P and Ca and concluded that the plants manufactured new atomic species.

The most well-known and extensive works in this field are those of Kervran, and on this basis, he was proposed for the Nobel Prize.[25] His work was examined by a committee of the U.S. Army Materials Technology Laboratory, which published a report in 1978 entitled "Energy Development from Elemental Transmutation in Biological Systems." The report concluded that transmutation took place at a cellular level (see reprint in *Infinite Energy*, No. 3, 18, p. 78). The Army report included a proposed mechanism. Mg ATP was considered to be a micro-cyclotron. When Mg ATP molecules are placed in layers, one on top of the other, the authors thought they could be seen as having the properties of a cyclotron.

Very remarkably, this 1978 report by an established committee has been ignored (as was the U.S. government work on the successful production of neutrons from passing electricity through wires). The work of H. Komaki in Japan[46] and V.I. Vysotskii *et al.*[47] in the Ukraine and Russia has also supported the remarkable paradigm of nuclear transmutation in biological systems. The more recent cold fusion and low-energy nuclear reaction work following the Fleischmann-Pons announcement in March 1989 has generally been viewed as a new development, unconnected with past research.

M. Puri,[26] a theoretical physicist, has reported some experiments on the germination of ryegrass seeds. The seeds were germinated for twenty-nine days. Evian water (which was analyzed for K, Mg, and Cu) was added (see Table 2).

Puri also reports experiments on the Ca in hens eggs. The normal diet of hens does not contain enough Ca for one egg. If the hens were kept away from Ca-containing foods, they laid eggs with thin shells devoid of Ca. If K (element 19) was added to the diet, the hens laid eggs with thick shells containing Ca (element 20).

Table 2. Results of Puri's Experiment

	Before germination (milligrams)	Change after germination (with grams)
		(After correcting for Evian water)
K	6.97	+ 9.31
Ca	6.00	- 2.61
Mg	10.32	-10.14
Cu	0.021	+ 0.079

Table 3. Chronological Summary of First Observations of Cold Nuclear Reactions in Various Systems

Phenomenon	When Firt Observed	Date of First Publication
Vanquelin, chicken excreta	1799	M. Kushi, *The Philosopher's Stone*, One World Press, 1994
Baranger, P and Ca in germinating seeds	1960	As Above
Kerveran, numerous biological observations of elemental transmutation	1966	L. Kerveran, *Biological Transmutation*, Beckman, NY 1971
Komaki, experimented on the content of P, K, and Ca in bacteria, compared with the removal of each of these successfully in nutrients	1967	I. Komaki, *Rev. de Pathologie Comp.* 67 (1967) 213
Kushi, Na → K; K to Ca; Mn to Fe	1967	M. Kushi, in book quoted above
U.S. Government Labs, neutrons from high currents through wires	1970	P. Graneau and N. Graneau, *Newton vs. Einstein*, Carlton, NY, 1994
Speri and Zorza, interpretation heat increase obtained in combustion if mixture sparked	1974	H. Bertocci and T.P. Wesh, Ref. 15
U.S. Government reports	1978	"Energy Development from Elemental Trammate in Biological Systems," U.S. Army Materials Technology Laboratory 1978, quoted by M. Kushi, ref as above
Fleischmann, Pons, and Hawkins, heat and neutrons from Pd-LiOD electrolysis	1989	M. Fleischmann, S. Pons, and M. Hawkins, *J. Electroanalyt. Chem.*, 267 (1989) 301
Packham *et. al.*, Direct measure of tritium from Pd-LiOD electrolysis	1989	N.J.C. Packham, K. Wolf, J.C. Wass, R.C. Kainthla, and J. O'M. Bockris, *J. Electroanalyt. Chem.*, 270 (1989) 451
Appleby and R. Bush, pure Li^6 solution gave same results as natural Li	1990	Ref. 29
M. Miles and R. Bush, He^4 in gas phase following	1991	R.E. Bush, T.J. Lagowski, M.W. Miles, and G.S. Osi, *J. Electroanalyt. Chem.*
Murphy, Li 4000 Å deep into Pd	1990	Presented ICCF-1, 1990
Monti, in letters advocated general occurrence cold nuclear reaction based on a particle theory of nucleus, Brown's gas, played on radioactive waste → diminution radioactivity	1990	Letters to JOMB, 1990
Chien *et al.*, He^4 found in Pd after electrolysis in D_2O	1992	Ref. 30
Reifenschweiller, heat reduces activity of tritium	1966	O. Reifenschweiller, *Phys. Letts. A*, 184, (1994) 149
Champion, impact method gives Au and noble metals from Hg and Pb	1992 (April)	Ref. 11
Long, γ emission from gas discharge tube	1992	H. Long, ICCF-3, Nagoya, p. 447
Notoya, γ emission from electrolysis of LiOH-Pd	1996	R. Notoya, T. Onnishi, and Y. Noya, ICCF-6, Hokkaido 1996, 675
Gleason, a.c. electrolysis of $Th(NO_3)$ gives diminution of radioactivity	1995	
Bockris and Sundaresan, C arc → Fe in D_2 containing H_2O	1994	Ref. 17
Bockris and Minevski, electrolysis of LiOH on Pd → numerous new metals	1993	Ref. 20
Speck, X-ray emission from Pd in LiOD-D_2O	1996	
Mundt, compressed trash, heated anaerobically → excess heat and radioactivity	1997	Ref. 26.

Speculative Interpretation of "Inedics"

There have been reports of persons ("inedics") who eat nothing but a daily communion wafer yet live for many years, apparently in excellent health, while performing daily manual labor. In skeptical modern times, nurses have lived with some of these for two weeks and have certified that no food in addition to the thin wafer eaten at communion was consumed.[27]

In view of the establishment by French, Japanese, and Indian workers of nuclear transmutation in biological organisms, may it be that, in the absence of enough food for chemical metabolism, there are rare cases in which a nuclear mechanism of metabolism comes into operation. Thus, water vapor, CO_2, O_2, and N_2 (*i.e.*, the elemental constituents of fats and proteins) are plentifully available from the body's normal breathing. According to the 1978 report on biotransmutation, excess energy is produced.

Geological Nuclear Reactions

The possibility that the Earth's internal heat is partially generated by nuclear reactions (that are not commonly understood radioactive decay) was, in part, the motivation that led physicist Steven E. Jones of Brigham Young University to his research in the period leading up to 1989. Jones and his group speculated that elevated helium-3 and tritium in volcanic emissions might indicate a geological cold fusion mechanism at work.[48] These functions might even be occurring in the core of the giant outer planet Jupiter, the group suggested, which would explain the excess radiated heat of that planet (about twice the solar radiation input). The group suggested that cold fusion in terrestrial matter might even be responsible for localized volcanism. The Jones group believed that the presence of localized concentrations of He-3 in diamonds and in metal foils was evidence of "cold piezonuclear fusion." Though he does not accept the nuclear basis of excess heat in "cold fusion" experiments, Jones still takes very seriously the geological/astrophysical implications of his work. (See his Letter to the Editor in this issue of *Infinite Energy*, p. 8.)

Theoretical Models

Biotransmutations are well discussed by Mizuno[22] and by Kozima.[5] An all embracing theory must account for the long (500 hours) delay in a switch on of nuclear effects in electrolysis of D-Pd-LiOD, irreproducibility that is diminished by the use of codeposition of D_2 and Pd on Au, and by use of thin films; internal damage in Pd; burst-like nature of the phenomena in Pd; occurrence in organic and biomaterials. No theory yet published accounts for all these effects. Mizuno[22] supports the ideas of E. Conte in which neutrons are formed by proton-electron combination. Kozima[5] has made a detailed case in which neutrons in the ambient enter all substances and are trapped there. These entities then undergo various reactions with Li, H, D, T, etc., and produce the observed effects. Although Kozima's model serves to explain the widespread nature of the effects (he sees neutrons as being "in" everything), his numerical analyses show the required neutron concentration to vary from 10^4 to 10^{13} cc^{-1} in D-Pd to achieve consistence, with results and this seems too large a range for consistency. Stress is put in Kozima's model on reaction with Li^6 but it was shown in 1990 by Appleby and Srinivasan[29] at Texas A&M that there was no difference in the heat evolved in Pd-LiOD in systems containing only Li^6 and those containing natural Li.

There are now literally dozens of other theories purporting to explain low-energy nuclear reaction phenomena. It will be a long time before all these are sorted out into viable and nonviable. For the present, work continues to determine just how

big is the "iceberg" of the low-energy nuclear reaction phenomenon, popularly thought to have begun with the work of Fleischmann and Pons. More grist for the theorists' mill.

Conclusions

Evidence (Table 2) for nuclear reactions in the cold comes from systems involving H and D in metals: tritium, helium, and new metals are produced. Arcs through gases and liquids give products containing new nuclei. Application of heat and electrolysis gives nuclear change in general. The latter also purportedly occurs when trash is heated anaerobically. Finally, there is strong evidence for nuclear reactions in biological systems. It is speculatively suggested that scientifically verified cases in which people remain well for years without imbibing more than a communion wafer per day while doing manual labor might sustain themselves by means of nuclear reactions in the body. Thus, in 1999 it is known that cold nuclear reactions occur in metal-H—radioactive, chemical, and biological systems. May they, then, be widespread through Nature, such as in geological and many astrophysical systems?

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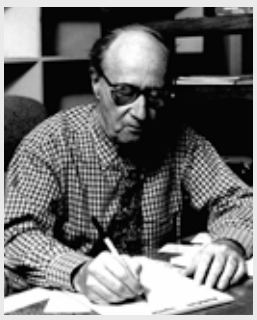
Dr. John O'M. Bockris received a B.Sc. degree in Chemistry with First Class Honors from the University of London in 1943, the degree of Ph.D. in 1945, and the degree of D.Sc. in 1952. After receiving his Ph.D., he became a member of the faculty of Imperial College, where he formed a significant research group in electrochemistry. After emigrating to the United States, he became Professor of Chemistry at the University of Pennsylvania in 1954. From 1982-1997, Bockris was a Distinguished Professor of Chemistry at Texas A&M University. He is the author of two books and numerous articles. Bockris founded the International Society for Electrochemistry (1949) and helped found the International Society for Hydrogen Energy (1974). He has received numerous awards and appointments in his field.



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Wisdom is not how much you know, but how you use what you know.

Submitted by Walter S. Rosenthal