

R.G.

ER-16
RGajewski
6/20/89

JUN 22 1989

ER-10
DStevens
6/22/89

Professor John O'M. Bockris
Department of Chemistry
Texas A&M University
College Station, TX 77843-3255

ER-61
DMayhew
6/22/89

Dear Professor Bockris:

This will acknowledge, with thanks, the draft manuscript "Observation Of Tritium Production During Electrolysis Of Heavy Water Samples Using Palladium Wires" which you recently sent to Admiral Watkins, Secretary of Energy.

ER-60
MAcler
6/21/89

As you know, the Department of Energy (DOE) carefully monitors research pertaining to the recently reported phenomena accompanying the electrolysis of heavy water in the presence of a palladium cathode. In fact, a specially formed Cold Fusion Panel of the Energy Research Advisory Board (ERAB) is scheduled to visit Texas A&M University shortly. The Board will report to the Secretary on its findings; a preliminary report is due by July 31, with a final report due on November 15, 1989. I am sure that your observation of high level tritium production will be considered by ERAB and may very well be factored into their report which, in turn, is likely to influence future DOE actions.

Your thoughtfulness in informing the Department of Energy of your finding is truly appreciated. Please keep us posted on any further developments.

With kind personal regards,

Sincerely,

151

Ryszard Gajewski, Director
Division of Advanced Energy Projects
Office of Basic Energy Sciences, ER-16

cc:
ERAB (w/incom.)

bcc:
ES/4, ER-60, ER-61 (Gtn), ER-16, ER-622 (Forstl)
ER-16:RGajewski:sad:3-5995:6-19-89:c:Gajewski:Slaughter
ES# 89-008439 ER# 89-251

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

U.S. DEPARTMENT OF ENERGY
CORRESPONDENCE CONTROL FOR
OFFICE OF THE EXECUTIVE SECRETARIAT

15:51

ACTIVITY CHANGE DO NOT DETACH FROM ORIGINAL CORRESPONDENCE
SOURCE CODE PM PUBLIC MAIL

CONTROL NO: ES89-008439
 SPEC INT: _____ DATE CORR: 06/12/89 DATE RECD: 06/12/89 DATE CNTRL: 06/12/89 DATE DUE: 06/26/89
 LETTER: X MEMO: _____ TWX: _____ OTHER: _____ TO: SECY: X DEP SEC: _____ UN SEC: _____ OTHER: _____

FROM: BOCKRIS, J O'M TX 0
TEXAS A&M UNIVERSITY

SUBJ: RESEARCH & TECHNOLOGY
GENERAL
OBSERVATION OF TRITIUM PRO-
DUCTION DURING ELECTROLYSIS OF
HEAVY WATER SAMPLES USING
PALLADIUM WIRES

REMARKS:

FOR USE BY ACTION OFFICE ONLY

	ACTION REFERRED TO	DATE	RETURN TO	DU DATE
1				
2				
3				

ACTION TO: ER TYPE ACTION: Reply direct SIG OF: ER
 CONCURRENCE: _____
 INFORMATION: S DS US DP MA1.22 D04 CONTROL ANALYST: B. ATCHERSON...50
 FILE CODE: PMMULTI-ES89008439

ALL DOCUMENTS FOR THE OFFICE OF THE SECRETARY
MUST BE FORWARDED TO THE OFFICE OF THE EXECUTIVE SECRETARIAT FOR FINAL PROCESSING

U.S. GPC 1-80-437-171

FROM: <u>Bockris, J O'M</u> <u>Texas A&M University</u>		DATE OF DOCUMENT: <u>Undated</u>	DATE RECEIVED: <u>6/14/89</u>	NO: <u>89-251</u>
TO: <u>James Watkins</u>		LTR: <u>X</u>	MEMO:	REPORT: <u>X</u>
REG. NO:		DUE DATE: <u>6/22/89</u>	FILE CODE:	DATE ANSWERED: BY:
DESCRIPTION (Must Be Unclassified) <u>Observation Of Tritium Pro-</u> <u>duction During Electrolysis Of</u> <u>Heavy Water Samples Using</u> <u>Palladium Wires</u>		REFERRED TO:	DATE	RECEIVED BY:
ENCLOSURES:		<u>Gajewski-Action</u>	<u>6/14</u>	
REMARKS: <u>ES 89-008439 Reply direct</u> <u>DUE 6/22/89</u>		<u>I. Adler-Info</u>	<u>6/14</u>	
Destruction Record: COPY NUMBER(S) _____ PAGE COUNT _____ DATE: _____ DESTROYED BY: _____		ACTION		

We would welcome any comments etc,
that you may have, at your convenience.

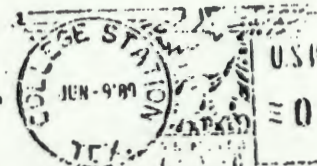
Tel. (409) - 845 - 5335

Fax (409) - 845 - 4205

DEPARTMENT OF CHEMISTRY
TEXAS A&M UNIVERSITY
COLLEGE STATION, TEXAS 77843-3255

Dr. J. O'M. Bockris
Dept. of Chemistry
Texas A&M University
College Station, Texas 77843-3255

OFFICIAL BUSINESS
STATE OF TEXAS
BY FE DPMALTY
FOR PRIVATE USE



Admiral James D. Watkins
Secretary of Energy
U.S. Dept. of Energy
1000 Independence Avenue, SW
Room 7A-257
Washington, DC 20585

DRAFT ONLY

OBSERVATION OF TRITIUM PRODUCTION DURING ELECTROLYSIS OF
HEAVY WATER SAMPLES USING PALLADIUM WIRES.

N.J.C. Packham, K.L. Wolf, M.E. McLain and J.O'M. Bockris

Department of Chemistry, The Cyclotron Institute, and Department of Nuclear
Engineering, Texas A&M University, College Station, Texas 77843

INTRODUCTION

A research group here has been studying an effect described by Pons and Fleischmann [1]. Research has centered around the investigation of the metallurgy of the palladium, anomalous heat production and the detection of nuclear emissions. Here, we describe the observation of tritium in seven out of eleven electrochemical cells, at levels which could not be produced by any process other than a nuclear one.

EXPERIMENTAL

The electrochemical cells used were 15 ml Pyrex centrifuge tubes, sealed with Viton rubber septa. Palladium samples supplied by the Texas Coin Exchange, 1 mm by 4 cm, and 3mm by 4 cm in dimension (99.9% purity) were prepared as shown in Table 1. All electrode connections were made using 99.9% pure nickel wire (0.5 mm). Nickel gauze anodes were used in all cases (99.9% purity). Electrode connections were fed through the rubber septum to the outside. 0.1M LiOD was prepared using 99.9% pure lithium metal from Alfa Associates, added to 99.9% pure deuterium oxide (Aldrich Chemical Co.), in an atmospheric bag containing argon. Additions to the cell (such as D₂O refilling) were performed by using disposable syringes (one use only), equipped with stainless steel needles. Gases evolved during electrolysis were

allowed to escape through a needle attached to Tygon tubing to a mineral oil bath to avoid light water contamination. All 1mm cells were at first run at 60 mAcm^{-2} for 14 to 16 days, the 3mm electrodes being charged for up to 28 days. After this time, the current density was increased to 500 mAcm^{-2} for periods of up to 8 hours. The cells were monitored electrochemically continuously during this time. Samples of electrolyte were withdrawn from the cell using a sterile syringe (later discarded).

Liquid Scintillation Counting (LSC) was performed using a LKB-Wallac Model 1219 Rackbeta LSC. A water soluble scintillation cocktail (Biosafe II, Research Products International Corporation) was added to 1 ml of sample. After allowing time for deexcitation of the cocktail, the samples were run in a double blind fashion. Blank samples of H_2O , D_2O , and 0.1M LiOD were also included for analysis. The efficiency of the detector for tritium was 33%. Analysis of samples was also confirmed in another instrument at this institution, and additionally by one private and three National laboratories.

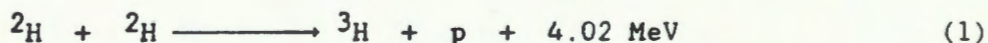
RESULTS AND DISCUSSION

The activity of the samples in disintegrations per minute per ml of solution are shown in Table 1. In one of the cells (designated A7) the build up of tritium as a function of time was followed at high current density, and the results are shown in Fig. 1. The possibility of chemiluminescence of the scintillation cocktail at 0.1M LiOD was ruled out by the experimental study shown in Fig. 2.

If tritium is produced only at high current density (cf. Fig. 1), based on the observed rate of tritium production, calculation shows that in the highest activity sample (cell A3), approximately 10^{10} atoms of tritium are produced per second, neglecting losses in the gas phase (which may be

appreciable).

If tritium is produced according to the following equation:



, at 10^{10} atoms per second this would be equivalent to 2 milliwatts, not detectable in the calorimeter at present in use in this laboratory. Cells A4 and B5 have also shown emissions of up to 50 neutrons per minute which will be described in detail elsewhere.

Although it has not been proved that the electrodes which produced the tritium reported here also produced the Fleischmann-Pons heat (approximately 10 Watts cm^{-3}), palladium electrodes prepared in a similar way did so. The ratio of total heat production to that accounted for by the tritium in solution, 5×10^3 , is a reasonable ratio (at 1 Ampcm^{-2}) for the gas (DT) retained in the solution, the rest escaping into the gas phase. The shape of figure 1 is consistent with the establishment of a quantity of DT in the electrolyte in equilibrium with DT in the escaping DT- D_2 mixture.

A problem is the sporadicity of the effect*. It is noteworthy that nickel anodes were used in the charging of electrodes which gave tritium. An alternative explanation may concern the times of charging of these electrodes. Negative results have been reported mainly for larger ($>2 \text{ mm}$) electrodes which might not yet be ready for high current density treatment until times approaching 2 months from initiation of charging.

One may speculate that tritium only forms in an electrochemical surface reaction when dendritic growths having low radii of curvature ($<10^{-5} \text{ cm}$) have

* But cf. Schoessow and Wethington [2] who have obtained 50,000 disintegrations per minute per ml.

formed on the surface^{**}. Here, at the low radius of curvature tips, local electric fields of approximately 10^{10} Volts cm^{-1} may bring the D^+ ion in transfer to an energy of $10 \text{ keV}^{\text{***}}$ sufficient to fuse with an adsorbed $\text{D}^{\delta+}$ on the electrode surface. The region of the electric double layer at the metal surface is known to be electron-rich [3] and thus provide the screening which may allow a D^+ having an energy in the 10 keV range to fuse with a surface D^+ .

ACKNOWLEDGMENTS

We acknowledge the financial assistance of the following; The Welch Foundation, the Electric Power Research Institute and Texas A&M University. We gratefully acknowledge the assistance of the following; Ross Lemmons, Bob Sherman and Roland Jalvert of Los Alamos National Laboratory, Dave Robertson and Russ Jones of Battelle, Pacific Northwest Laboratory, Kevin Myles of Argonne National Laboratory, Dennis Corrigan of General Motors Research Laboratory, and the following from Texas A&M University: Ramesh Kainthla, Omo Velez, Jeff Wass, Lamine Kaba, Guang Lin, Marek Szklarczyk, Arpad Szucs, Babli Kapur, Maria Gamboa-Aldeco, Anuncia Gonzales-Martin, Ljiljana and Zoran Minevski, Jeng King-Tsai, Yang Bo, Lin Chen, Peter Lee, and John Shoemaker.

REFERENCES

- 1 M. Fleischmann and S. Pons, J. Electroanal. Chem., 261 (1989) 301.
- 2 G.J. Schoessow and J.A. Wethington, private communication, 1989.
- 3 W. Schmickler and D. Henderson, J. Chem. Phys., 85 (1986) 1.

^{**} Scanning Electron Micrographs of the surface of electrodes prepared in a similar way to ours have shown dendritic growths

^{***} Equivalent to a temperature of approximately $10^8 \text{ }^\circ\text{K}$

FIGURE CAPTIONS

Figure 1. The production of tritium in the electrolyte of cell A7
(see Table 1) as a function of time.

Figure 2. The effect of electrolyte concentration on chemiluminescence of the
scintillation cocktail.

TABLE 1
Cell identification, electrode treatment, solution type and tritium activity of electrolyte samples.

CELL	ELECTRODE TREATMENT ^a	SOLUTION ^b	ACTIVITY (d min ⁻¹ ml ⁻¹)
A1	A	1	3.8 x 10 ⁴
A2	A	2	315
A3	B	1	4.9 x 10 ⁶
^c A4	B	2	1.2 x 10 ⁵
A5	C	1	3.7 x 10 ⁶
A6	C	2	3.3 x 10 ⁴
A7	D	1	
	Before high current density		249
A7	After 2 hours at 500 mAcm ⁻²		5370
A7	After 6 hours at 500 mAcm ⁻²		5.0 x 10 ⁵
A7	After 12 hours at 500 mAcm ⁻²		7.6 x 10 ⁵
A8	D	2	339
B3 (3mm)	B	1	6.3 x 10 ⁴
B5 (3mm)	C	1	195
CELL 1 (6mm)	A	1	264
D ₂ O			195
0.1M LiOD			225
Neutralized 0.1M LiOD			220
Neutralized 0.1M LiOD + 0.1mM NaCN			230

^a Key for electrode surface pre-treatment: (A) No surface pre-treatment; (B) anneal 800 °C, 10⁻⁶ torr, 8 hours; (C) acid etch, 5M HCl, 15 minutes; (D) electrochemical oxide removal, 2 hours

^b Key for solution type: (1) 0.1M LiOD; (2) 0.1M LiOD + 0.1mM NaCN

^c Cell that has shown neutron activity up to 50 neutrons per minute.

TIME PROFILE OF TRITIUM PRODUCTION FROM CELL A7

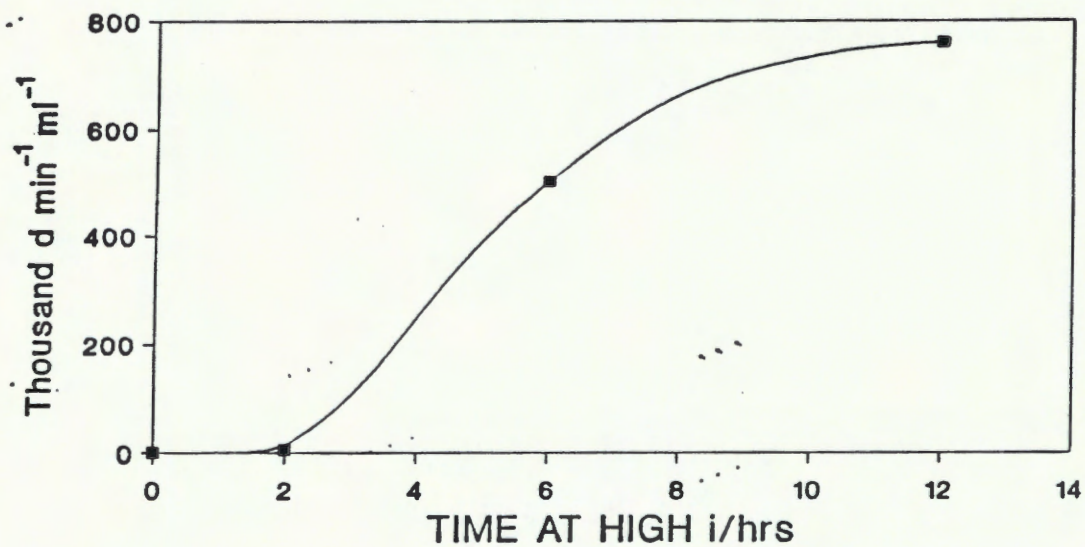


Figure 1 Packham et al Tritium Production.

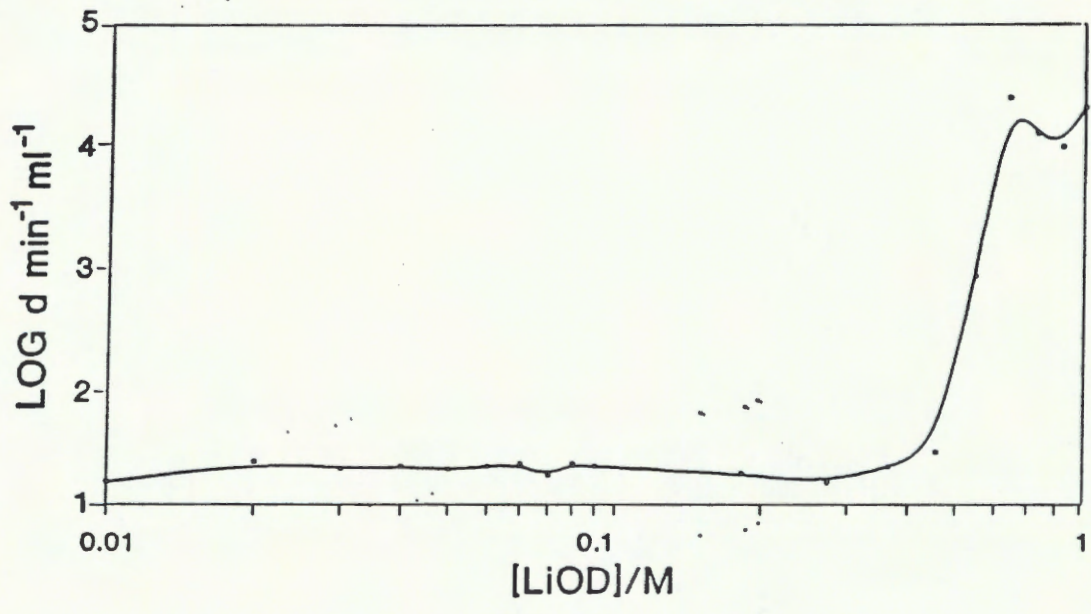


Figure 2 Packham et al. Tritium Permeation