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Trace Elements Added to Palladium by Electrolysis in Heavy Water

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Abstract

EPRI sponsored an experimental program to investigate the trace element changes brought about in palladium after extensive electrolysis in heavy water electrolytes. Of particular interest were cathodes which had experienced episodes of excess heat production beyond all electrical and other inputs. This report details the careful analysis of a particular cathode by neutron activation (NAA) as compared with the identical simultaneous analysis of virgin palladium material from which the cathode was fabricated.

Background

Palladium (Pd) cathodes electrochemically charged with deuterium (D) have exhibited episodes of excess heat beyond all inputs. To confirm or refute the suspicion of a possible nuclear reaction producing the excess heat, trace element changes were measured in a cathode with a history of excess heat production relative to the amounts present in virgin material from the same palladium production batch.

Objective

To measure by an unequivocal method, namely (NAA), low levels of elements added to a palladium cathode during a lengthy electrolysis in 0.1 to 1.0 molar lithium deuteroxide during which excess heat production had been observed.

Approach

The project team performed neutron activation analyses (NAA) of a small diametral slice of a 2 mm diameter PD rod cathode and a similar slice of the virgin rod from which the cathode had been originally fabricated. All elements susceptible to NAA at a flux of 1E12n/cm2-sec under irradiations of 10 minutes and 3 hours were detected and reported. Since NAA is isotope specific, any changes in the isotopic ratios within palladium were also accessible by this method.

Results

Increases in the elements cobalt (Co) (>4X), chromium (>5.4X), cesium (Cs) (>2X), europium (Eu) (1.3X), iron (Fe) (56X), and zinc (Zn) (12X) were noted relative to the virgin material. The conventional explanation for such increases is the cathodic deposition of electrolyte impurities on the cathode surface. The samples were slices through the diameter of the cathode rods and hence the surface layer was minimized relative to the bulk. However, the sample analyzed had some 0.033 cm2 of surface area, less than five percent of the total surface exposed to the electrolyte. The ratio of Pd-108 relative to Pd-110 in both samples was also measured. Pd-108 was depleted in the active sample relative the virgin material by an apparent 28 percent with the one sigma error limits extending from seven percent to 49 percent.

EPRI Perspective

The cathode sample along with the virgin material were volunteered by S.Pons of IMRA. However, the precise amounts of excess heat produced by this cathode have not yet been made available. Hence it is not yet possible to relate these elemental changes to a specific quantity of excess heat. The isotopic ratios of the added elements should be those of the elements found naturally. The only heat producing nuclear reaction capable of producing Cr, Co, Fe and Zn is the fission of palladium isotopes. If the apparent depletion in Pd-108 is confirmed, this may indicate that the lighter isotopes of Pd are more susceptible to fission than the heavier ones. Clearly this one experiment is not definitive, only suggestive. NAA could be used to find whether or not the Zn-64/Zn-68 ratio of the added Zn is significantly different from natural. It is also interesting to note that NAA measurements on other cathodes have also shown significant zinc increases. Since the zinc in at least one of those cases, cathode C-2 from work at SRI International, was mostly at the surface, it was assumed at the time that it was there by conventional cathodic deposition from electrolyte impurity zinc. However it is plausible that nuclear processes producing zinc also favors the surface. Again, the proof of a nuclear source for the increased zinc (and possibly other multi-isotope elements), will be resolved by NAA that shows the isotopic abundance ratios to be significantly different from those found naturally. Related EPRI reports include TR-104195, TR-104188, TR-108474, and Volume 1 and 2 of TR-107843.

Program

2005 Program 041.0 Nuclear Power

History

2004 Program 041.0 Nuclear Power
2003 Program 041.0 Nuclear Power
2002 Program 041.0 Nuclear Power
2001 Program 041.0 Nuclear Power
2000 Program 031.0 Nuclear Power
1999 Program 088.0 Nuclear Power

Keywords

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Report

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Note

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