

Recent Advances in Deuterium Permeation Induced Transmutation Experiments using Nano-Structured Pd/CaO/Pd Multilayer Thin Film

Y. Iwamura, S. Tsuruga, T. Itoh

Advanced Technology Research Center, Mitsubishi Heavy Industries, Ltd., Japan
E-mail: yasuihiro_iwamura@mhi.co.jp

Permeation induced transmutation reactions, which we originally found in the nano-structured Pd multilayer film composed of Pd and CaO thin film and Pd substrate [1], have been observed in our laboratory and other research institutes[2]-[4]. Recently, Toyota R&D centre reported almost complete replication experiments on the transmutation of Cs into Pr at ICCF-17[2]. We observed transmutation reactions of Cs into Pr, Ba into Sm, W into Pt up to now. Especially, transmutation of Cs into Pr has been confirmed by “in-situ” measurements using x-ray fluorescence spectrometry (XRF) at SPring-8 in Japan [5].

Experimental data that indicates the presence of transmutation have been accumulated and the underlying mechanism for inducing low energy transmutation reactions is gradually becoming clear, although systematic experimental study is still insufficient. The permeation induced transmutation technology would be expected as an innovative nuclear transmutation method for radioactive waste and a new energy source if we would be able to increase the amount of transmutation products.

We have been trying to increase the amount of transmutation products these years for the practical application. The following factors are assumed to be important for inducing deuterium permeation transmutation.

- 1) Local Deuteron Density
- 2) Electronic Structure

Based on this assumption, we applied an electrochemical method to increase the local deuteron density near the surface of the nano-structured Pd multilayer film. We also tried to increase the transmutation products by changing surface electronic state. These recent experimental methods gave us increased transmutation products, gamma-ray emissions, and new implications on Deuterium Permeation Induced Transmutation.

References

- [1] Y. Iwamura, M.Sakano and T.Itoh, “Elemental Analysis of Pd Complexes: Effects of D₂ Gas Permeation”, Japanese Journal of Applied Physics, Vol.41, (2002) pp. 4642-4650.
- [2] N. Takahashi, S. Kosaka, T. Hioki and T. Motohiro, “Detection of Pr in Cs ion-implanted Pd/CaO multilayer complexes with and without D₂ gas permeation”, Proc. of ICCF17, to be published.
- [3] T. Higashiyama, M Sakano, H. Miyamaru and A. Takahashi, “Replication of MHI Transmutation Experiment by D₂ Gas Permeation Through Pd Complex”, Proc. of ICCF10, edited by P. H. Hagelstein et al., Condensed Matter Nuclear Science, World Scientific, New Jersey (2006) pp.447-454.
- [4] H. Yamada et al., Producing Transmutation Elements on Plain Pd-foil by Permeation of Highly Pressurized Deuterium Gas, Proc. of ICCF12, ed. by A. Takahashi et al., Condensed Matter Nuclear Science, World Scientific, New Jersey (2006)pp.196-205.
- [5] Y. Iwamura, T. Itoh, N.Yamazaki, J. Kasagi, Y. Terada, T. Ishikawa, D. Sekiba, H. Yonemura and K. Fukutani, “Observation of Low Energy Nuclear Transmutation Reactions Induced by Deuterium Permeation through Multilayer Pd and CaO thin Film”, J. Condensed Matter Nucl. Sci. vol.4 (2011) pp.132–144.