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THE ITALY-JAPAN PROJECT-FUNDAMENTAL RESEARCH ON COLD TRANSMUTATION PROCESS FOR TREATMENT OF NUCLEAR WASTES

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Abstract

The IJ Project proposes, as the first phase research, that confirmation of the cold transmutation using radioactive isotopes as Cs-137, Sr-90 and Cs-135 to non-radioactive elements will be implemented based on the MHI method.
A theoretical background has been given by the TSC-induced nuclear reactions[3)]. Charge-neutral pseudo-particle of 4d/TSC can become as small as 10 fm radius in its minimum state of squeezing motion and will make 4D-capture reaction with host metal (or added metal) nuclei in the surface region of permeation[1,2)] samples. Major reaction will be:

$$M(A,Z) + 4d/TSC \rightarrow M(A+8, Z+4) + Q$$

Theoretical modeling of the process is briefly explained and resulting reaction products, their decays and final stable isotopes are predicted for Cs-137, Sr-90 and Cs-135 transmutations.

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1. Introduction

Recent studies on condensed matter nuclear effects in/on near surface regions of metal-deuterides and -hydrides have provided some confident experimental results about occurrence of Cold Transmutations in condensed matter containing deuterium and hydrogen[1-3]. Especially the latest works by Iwamura et al[4,5] are strange and important enough to be new findings of condensed matter nuclear effects. Iwamura et al have repeatedly shown that there occurs selective transmutation from ^{133}Cs to ^{141}Pr (or ^{88}Sr to ^{96}Mo) in the experimental system of D-gas permeation through Pd-complex samples. Pd-complex samples are made with multi-layered Pd/CaO/Pd plates in nm size processing.
The IJ-Project aims at confirming the selective transmutation process by using special samples containing radio-active Cs and Sr. This is pure basic science project.

2. Selective Transmutation

This new type of transmutation should be the process to add 4D or ^{8}Be to host element M(A,Z) and to transmute to M'(A+8, Z+4). Therefore, some kind of coherent multi-body process in condensed matter should be existing as underlying physics mechanism. One scenario of theoretical interpretation has been proposed by Takahashi[6].

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$$M(A,Z) + 4d/TSC \rightarrow M(A+8, Z+4) + Q \qquad (1)$$

Iwamura et al has also reported[7] that 6D added transmutation. Takahashi[6] has proposed a model for 6D/OSC process to interpret it.

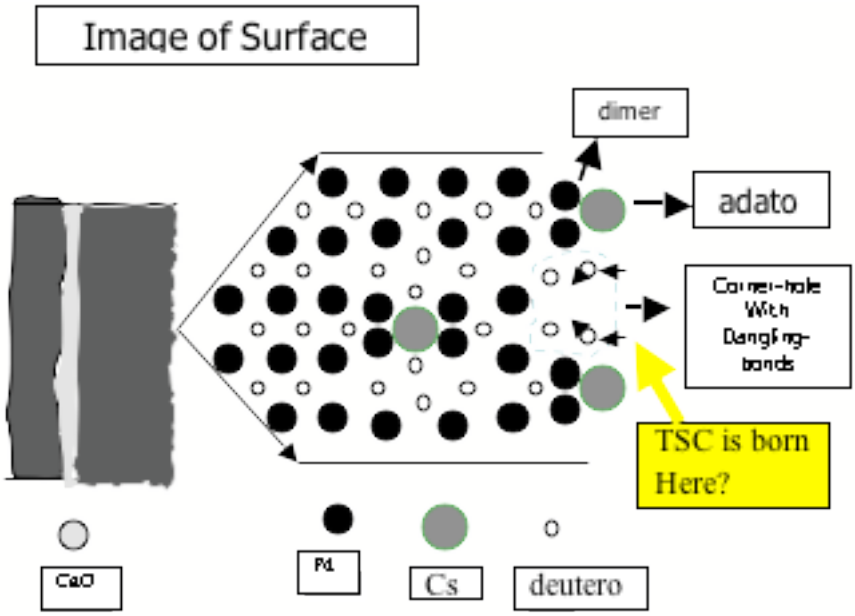

Fig.1 Model of surface of Iwamura type sample

If we do experimental tests using radio-active samples of e.g., ^{137}Cs, ^{135}Cs and ^{90}Sr to confirm significant decrease of their radio-activities, the transmutation effect will be very clearly

confirmed in the view of nuclear science. Then we may argue on the possibility of application to remediation for long-lived radio-active wastes from nuclear plants, although it requires drastic scale up of transmutation rates, compared with the original claim by Iwamura et al.

3. Model of TSC-Induced Transmutation

According to Takahashi model of TSC-induced reaction, 4D/TSC at its minimum-size state of squeezing motion may behave as a very small (about 10 fm in diameter) pseudo-particle of neutralized electric charge. A model of formation mechanism on surface of Iwamura sample is shown in Fig.1. Surface elements analysis by TOF-SIMS by Iwamura[5, 7] revealed that supposed transmutation took place within 10 nm depth zone from surface of Pd-complex sample plate. Fig.1 models some sites like corner holes to provide site for TSC formation.
Then TSC squeezing motion produce TSC-minimum-size state of about 10 fm diameter to approach and make strong force exchange with host metal nucleus as shown in Fig.2.

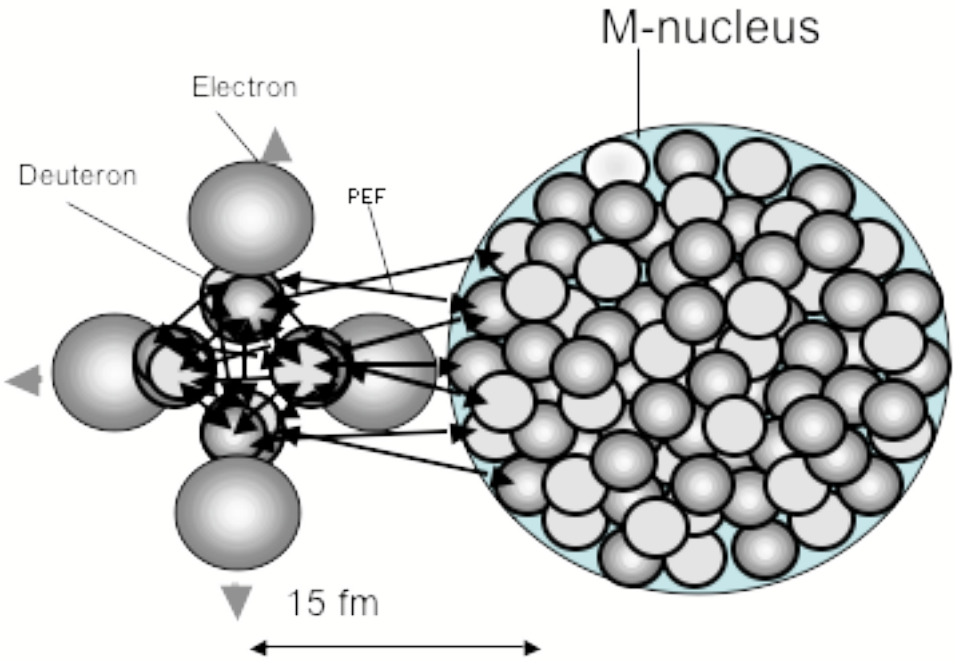

Fig.2: Strong interaction (PEF) between TSC-minimum-size and host-metal M-nucleus. The admixture of 4d/TSC forms ^{8}Be* compound state for short time.

Capture reaction rate for the process of Fig.2 can be approximately estimated by STTBA[6, 7]. For the ^{133}Cs + 4d/TSC to ^{141}Pr + Q process, 4.6E+14 Pr-atoms/week/cm^2 is estimated[6] and this value is close to Iwamura results[4].

4. Prediction for Radio-active Samples

The reaction scenarios by TSC-induced transmutation predict the following reactions and products for ^{137}Cs, ^{135}Cs and ^{90}Sr being considered for the IJ-Project.

$$^{133}\mathrm{Cs} + 4\mathrm{d/TSC} \rightarrow {}^{141}\mathrm{Pr(Ex{=}50.49MeV)} \rightarrow \mathrm{FPs}$$
$$\text{or } {}^{141}\mathrm{Pr(stable)} + \text{gammas} \qquad (2)$$

$$^{137}Cs + 4d/TSC \rightarrow {}^{145}Pr(Ex=45.63MeV) \rightarrow$$
$$\text{Fission-Products (in 10 fs) or}$$
$$^{145}Pr(5.98h)^{145}Nd(stable) + \text{gammas (in few fs)} \quad (3)$$

During the beta-decay of ^{145}Pr with 5.98 hours half life, there should be a small fraction (1%) of gamma-rays at Eγ = 675.8 keV and 748.28 keV, which we can detect with HpGe detector to identify the occurrence of reaction (3).

$$^{135}Cs + 4d/TSC \rightarrow {}^{143}Pr(Ex=48.03MeV) \rightarrow$$
$$\text{Fission-Products (in 10 fs) or}$$
$$^{143}Pr(13.57d)^{143}Nd + \text{gamma (in few fs)} \quad (4)$$

$$^{90}Sr + 4d\ /TSC \rightarrow {}^{98}Mo(Ex=54.71MeV) \rightarrow$$
$$\text{Fission-Products (in 10 fs) or}$$
$$^{98}Mo(stable) + \text{gammas (in few fs)} \quad (5)$$

For all cases, fission channels may be opened due to very high excited energies of intermediate compound nuclei. However, we predict gamma transitions will be more dominant than fission, due to shorter transition times (few fs) than about 10 fs life for fission break up by collective deformation of excited nuclei (dumbbell oscillation).

Gamma-transition from highly excited states may emit very high energy gamma quanta in about 50 MeV range. To detect and identify these very high energy gamma-rays is difficult and money consuming effort is needed, because the process for detection is mostly by Compton scattering and we do not have definite method for unfolding broadened pulse height spectra of observation with usual detectors (NaI, Ge, etc.).

5. Conclusions

TSC as small neutral pseudo-particle induces nuclear reaction with host metal-nucleus.
Cold transmutation by high energy ^{4}He and ^{8}Be particles by self-fusion of 4d/TSC is also predicted.
Cold transmutation by TSC+Host-nucleus by 1) will be almost non-radio-active.
Confirmation by the IJ Project is expected
If Confirmed, Scale-up Study is expected.

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