Adv.-ORIENT Cycle,
for Separation and Utilization of Actinides and Nuclear Rare Metals

Separation, transmutation and utilization of actinide (An), long-lived fission products (LLFP) and rare metal in nuclear spent fuel have been studied as a trinitarian research program named *Adv.-ORIENT Cycle* (ref. Fig.1), to ultimately reduce environmental burden derived from radioactive wastes.

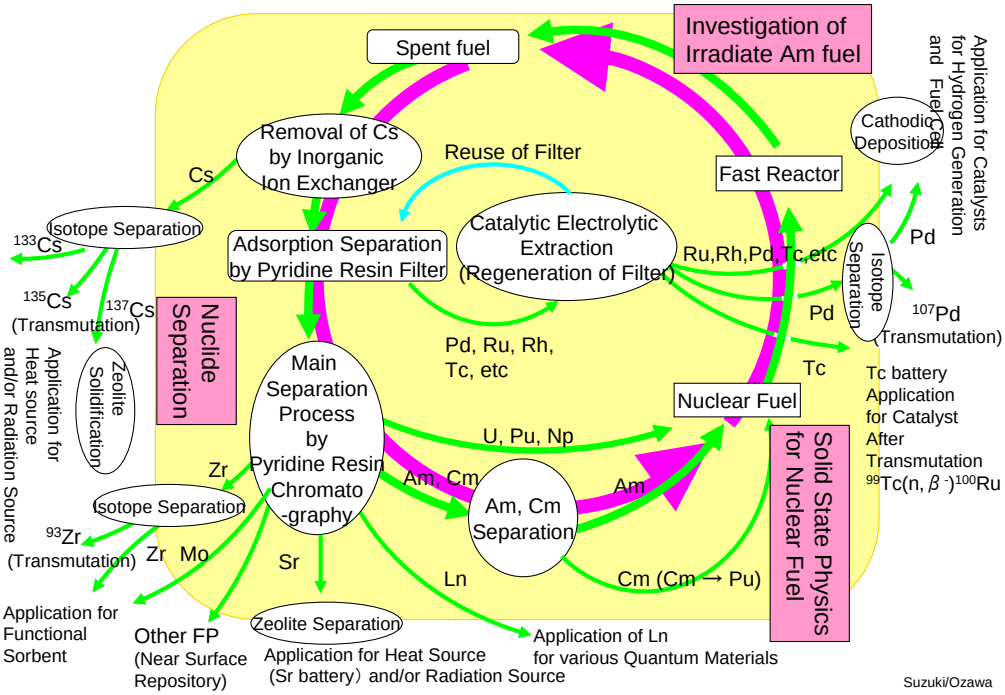
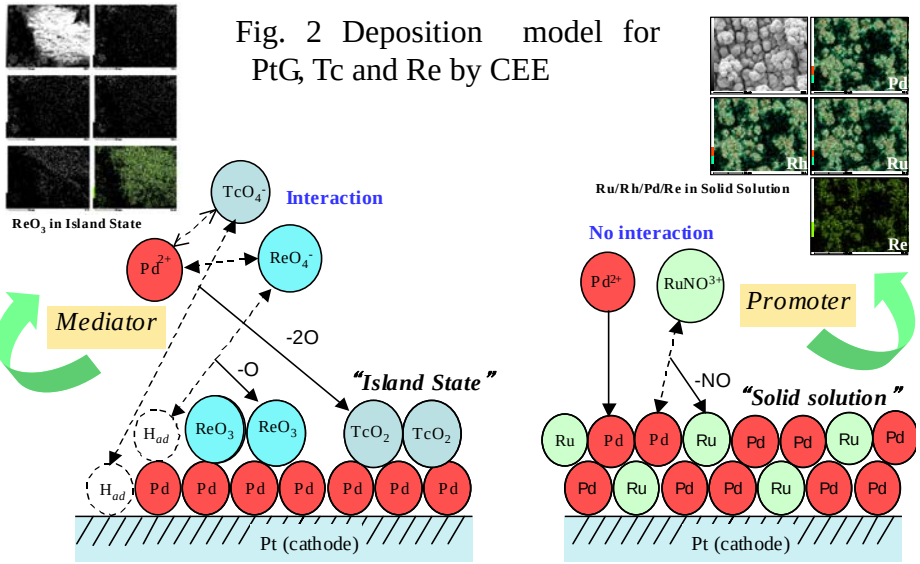


Fig. 1 Concept of Advanced ORIENT Cycle

In a highly burned fast reactor spent fuel, rare metals, including Tc (being categorized LLFP, also) and PtG, are rather abundant, more than *ca*. 30kg per metric ton of SF. Those ionic species can be selectively separated from high level liquid waste (HLLW) by either IXC by tertiary pyridine resin or catalytic electrolytic extraction (CEE) method (ref. Fig.2). Specific metallic cation such as Pd^{2+} and Rh^{3+}, co-existing in the HLLW solutions, may act as promoters (*i.e.*, Pd_{adatom}) or mediators, thereby accelerating electrochemical deposition of $RuNO^{3+}$, ReO_4^- (simulator Tc) and TcO_4^-. Under potential deposition(UPD) by Pd_{adatom} or Rh_{adatom} is effective. As current maximum deposition ratios of RMFP in nitric acid media were, 95-99% for Pd, 60% for Ru, >99% for Rh, 55% for Re and 25% for Tc, respectively. The current experiments revealed that the CEE process significantly accelerated the deposition of Ru and Re (>90% for both) as well as Tc (>50%) in hydrochloric media. Further improvement would be expected for Tc. Further experiments using real HLLW are planed. Catalyst for electrolytic hydrogen generation of sea water is one of the attractive applications of recovered rare metals. Nano/micro, quaternary (Ru-Rh-Pd-Re) deposited electrodes can be alternatives to the existing cathode in an alkali or sea water, with showing higher catalytic reactivity than that of smooth or black Pt electrode.

The highest number of hydrogen absorption sites (Q_{Had}) attributes to such high reactivity of quaternary deposits. will due. Additionally, the lower oxygen over potential may suggest another chemical application (ref. Fig.3).

Since tertiary pyridine resin can separate Am and Cm individually from the spent fuel, *Adv.-ORIENT Cycle* will improve rad. waste problem. Also, it will propose nuclear rare metal, PtG, Tc, Cs, Sr, Mo and rare earth, shall be alternative materials with a novel vision to bridge nuclear and forefront industries.



(a) Pd^{2+} as Mediator *(b) Pd_{adatom} as Promoter*

Fig. 2 Deposition model for PtG, Tc and Re by CEE

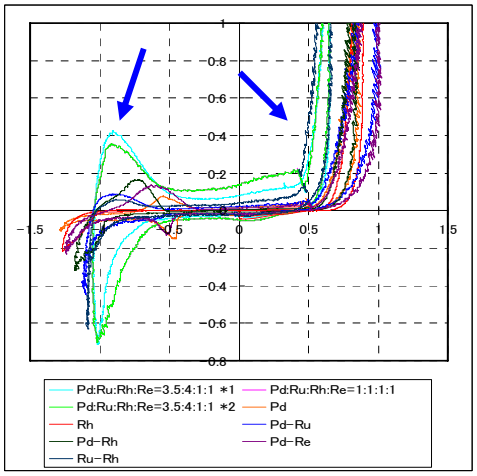


Fig. 3 CV of PtG and Re deposit electrodes in NaOH soln.

To proceed and widen the separation, transmutation and utilization concept, world-wide collaboration will be desirable. Specifically for ^{99}Tc, unknown and attractive artificial element, basic scientific research can open a new technological field to develop multilateral utilization in ex-nuclear industries in future.

References

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