Recent Activities on R&D of Innovative Extractants and Adsorbents for Partitioning of Minor Actinides at JAEA

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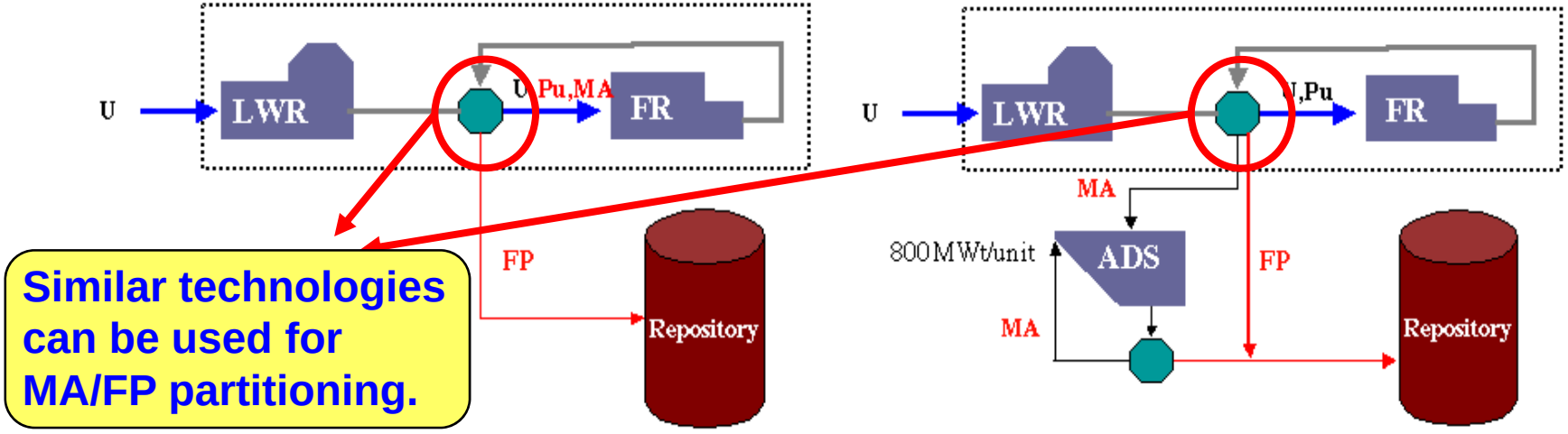
Outline

- **Introduction**
  - **Recent activities on aqueous partitioning at JAEA**
- **Recovery of An(III) with RE by solvent extraction**
  - **TRUEX process**
  - **DGA extraction** **poster III-15**
- **Separation of An(III) from RE by solvent extraction**
  - **SETFICS process**
  - **New extractants (PDA)** **poster III-23**
- **Application of chromatographic technology**
  - **Extraction chromatography**
  - **Tertiary pyridine resin** **poster III-12**

Two Concepts of P&T

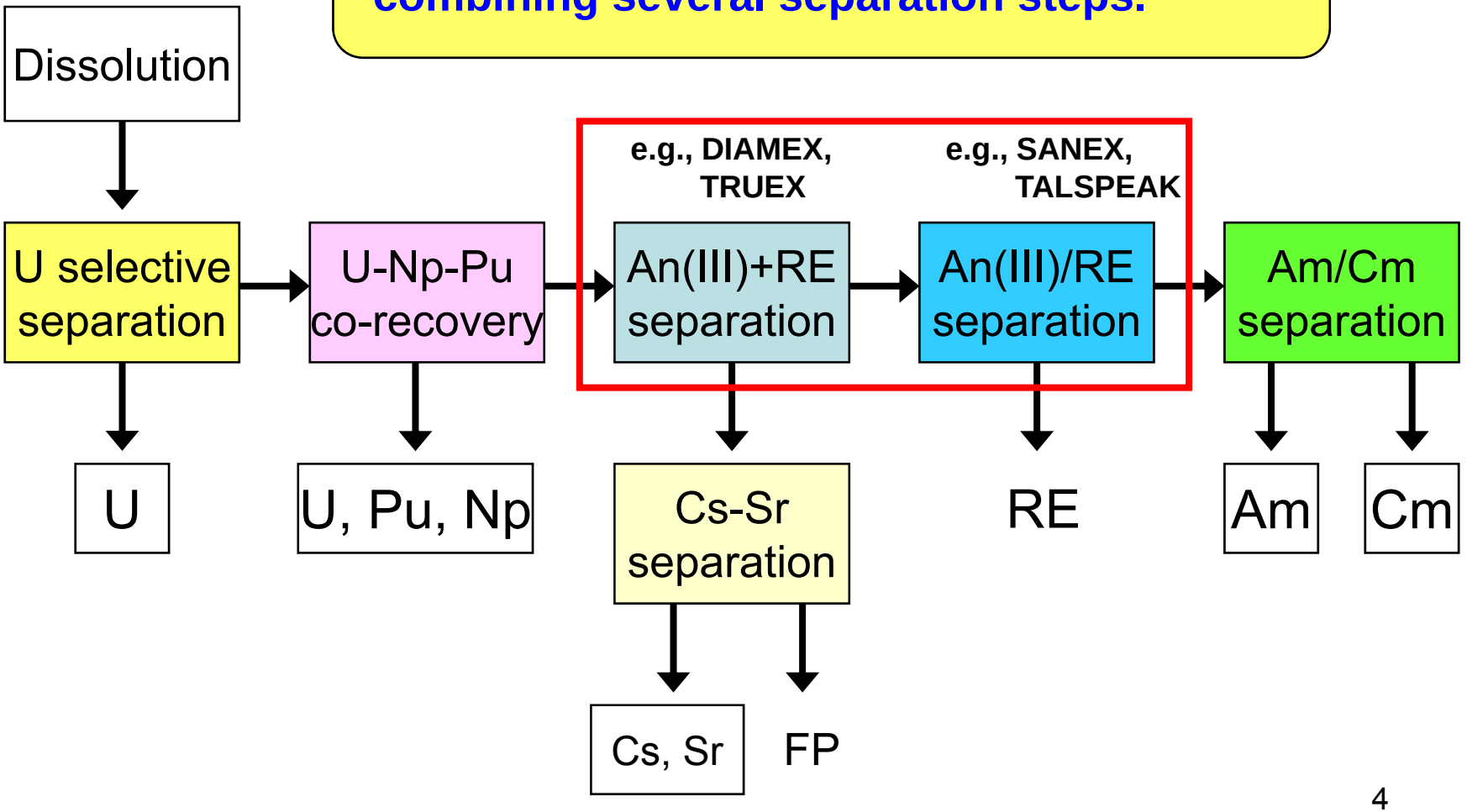
- **Homogeneous recycling** with commercialized FR
  - MA-MOX fuel with aqueous reprocessing
  - MA-bearing metal fuel with pyrochemical reprocessing
- **Double-strata concept** with accelerator driven system
  - MA-bearing nitride fuel with pyrochemical reprocessing



Homogeneous recycling **Double strata concept**

Separation Steps on Aqueous Partitioning

Partitioning process can be constructed by combining several separation steps.



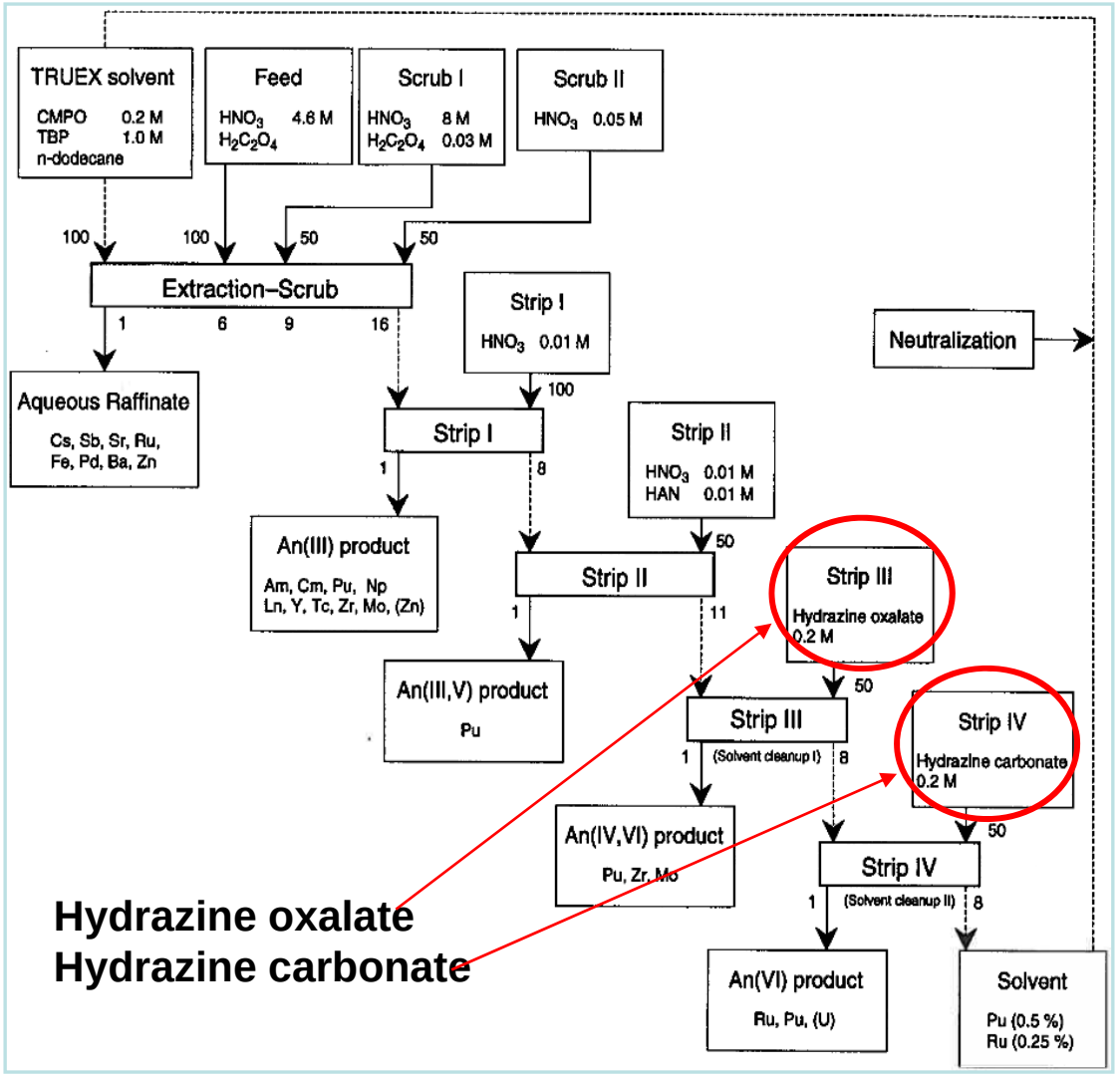
Recent Activities on Aqueous Partitioning

	NEXT Process*	The other methods & technologies
U selective separation	Crystallization	・Precipitation by pyrrolidone ・Solvent extraction by TBP (modified PUREX) ・Solvent extraction by N,N-dialkylamide
U-Np-Pu co-recovery	Co-extraction by TBP	・Solvent extraction N,N-dialkylamide
An(III)+RE separation	**Extraction chromatography (CMPO, TODGA)**	**・TRUEX (Solvent extraction by CMPO)** **・Solvent extraction by DGA-extractants** ・Solvent extraction by DIDPA
An(III)/RE separation	**Extraction chromatography (BTP, HDEHP)**	**・SETFICS (Extraction by CMPO with DTPA)** ・TALSPEAK (Extraction by DIDPA with DTPA) **・Solvent extraction (TPEN, TPA, PDA, BTP etc.)** **・Extraction chromatography (PDA)** **・Tertiary Pyridine Resin-HCl-MeOH**
Am/Cm separation	–	**・Tertiary Pyridine Resin-HNO_3-MeOH**
Cs-Sr separation	–	・Novel inorganic adsorbent (cation exchanger) ・Extraction chromatography

***Fast reactor cycle technology development (FaCT) project**

An(III)+RE Separation: TRUEX Process

- TRUEX is a promising process for TRU recovery from acidic solutions including a raffinate from PUREX-type solvent extraction.
- "Salt-free" reagents are utilized for stripping/back extraction of highly extractable U and Pu as well as washing solvent.
- Flowsheet proposed was demonstrated by a counter-current test using a real raffinate from FR "Joyo" fuel.



"Salt-free" TRUEX flowsheet

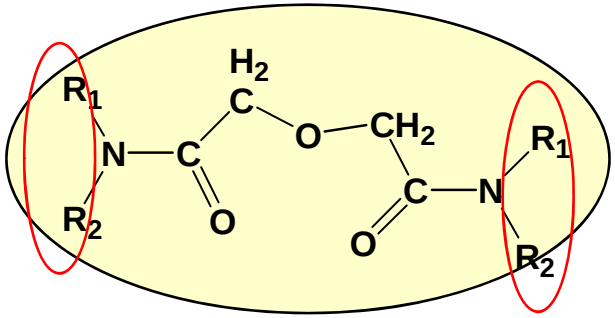
An(III)+RE Separation: DGA Extraction(1/2)

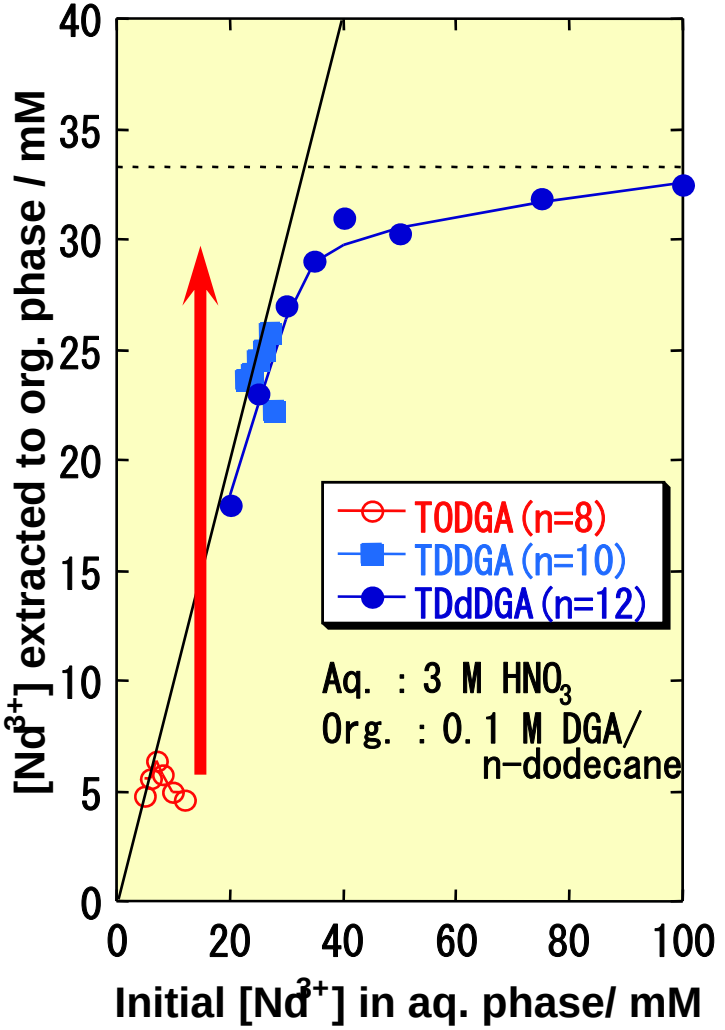
JAEA developed a novel extractant, N,N,N',N'-tetraoctyldiglycolamide (TODGA) for the recovery of actinides.

- Strong extractability for An(III) and An(IV) from higher HNO_3 solution

-High solubility in n-dodecane

- High stability for hydrolysis and radiation





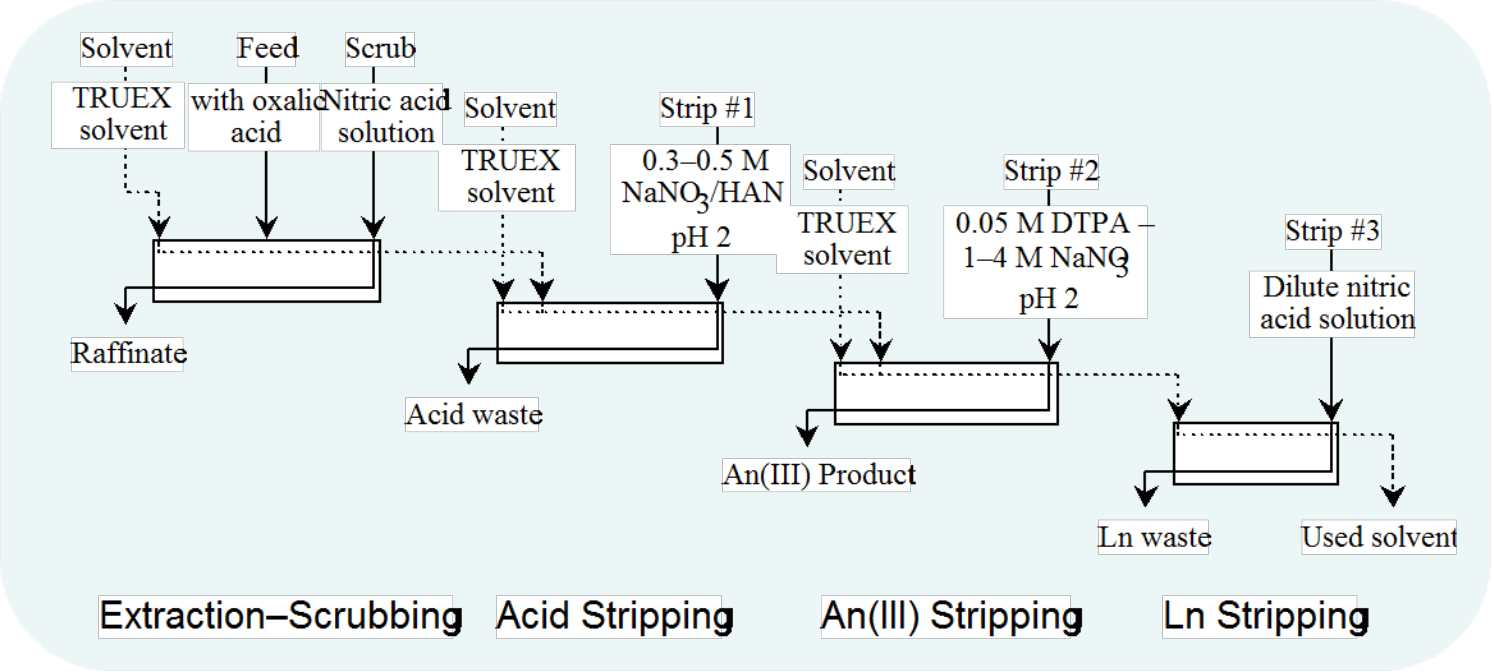
Modification of the alkyl groups attached to amidic nitrogen atoms

Extraction capacity of TODGA was improved about five times.

An(III)/RE Separation: SETFICS Process

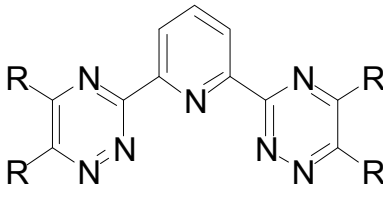
SETFICS: Solvent Extraction for Trivalent f-elements Intra-group Separation in CMPO-complexant System

- Improved flowsheet of TRUEX for light lanthanides separation was developed.
- An(III) is selectively stripped with DTPA and nitrate solution after TRUEX-like extraction–scrubbing.
- Flowsheet was successfully demonstrated to separate La, Ce, Pr and Nd, ≥ 90% of Ln(III), from An(III).

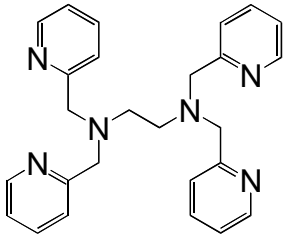


An(III)/RE Separation: New Extractants(1/2)

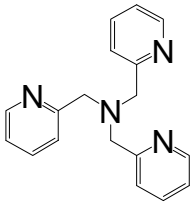
- N-type donor extractant for An(III)/RE separation



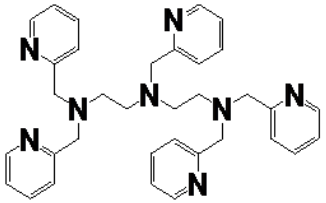
BTP



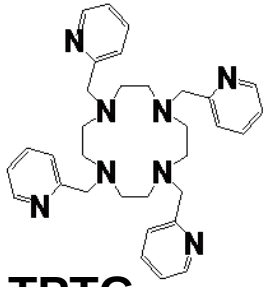
TPEN



TPA



PPDT

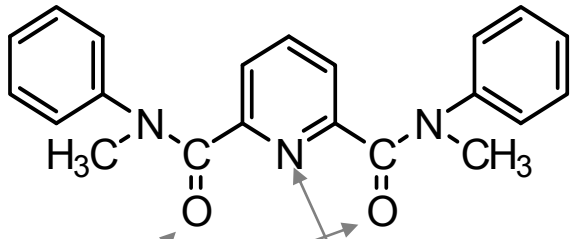


TPTC

Separation in acidic solution is difficult.
Chemical stability is rather low.

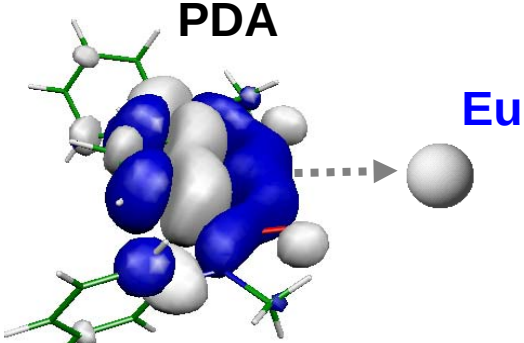
- NO-type hybrid donor extractant for An(III)/RE separation

NO-donor type extractant
Pyridine dicarboxyamide (PDA)



hard donor **soft donor**

PDA

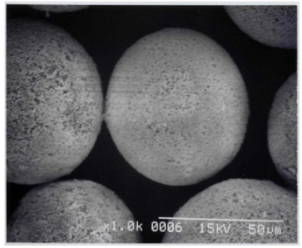


R_1=Ph R_2=CH

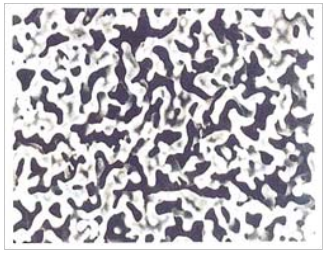
Electronic structure of PDA molecule (calculated by Gaussian98)

Extraction Chromatography(1/2)

- SiO_2-P: porous SiO_2 covered by SDB polymer
- Resin: extactants（CMPO,TODGA,BTP,HDEHP,etc）immobilized in SiO_2-P



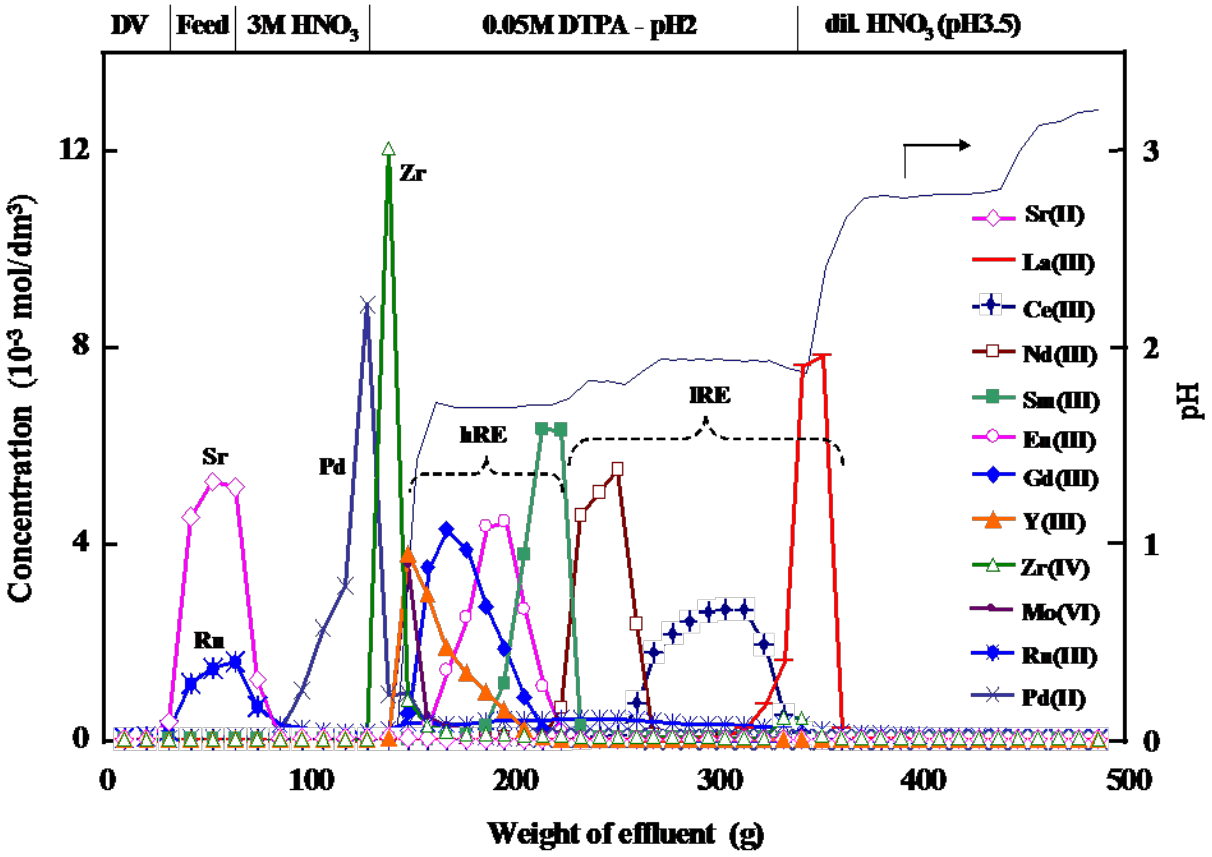
The CMPO/SiO_2-P resin



Cross section of the porous SiO_2

Extraction chromatography is under development as an alternative for solvent extraction with expectation of cost and waste generation.

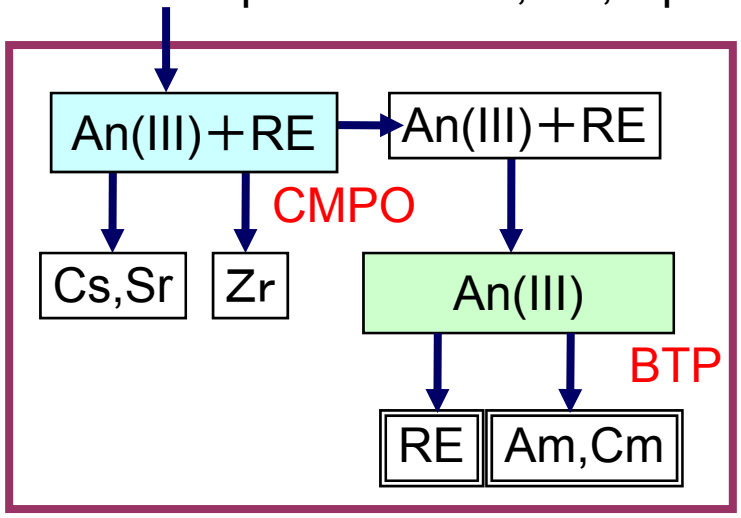
Packed column can be operated under high pressure for fast elution.

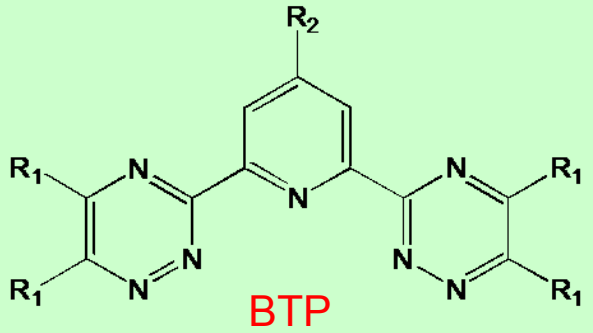


Separation tests for simulated HLLW by CMPO/SiO_2-P resin
(Column 10 mmφx 50 mm h, Flow rate 0.76 m/h, Temp. 323K)

Extraction Chromatography(2/2)

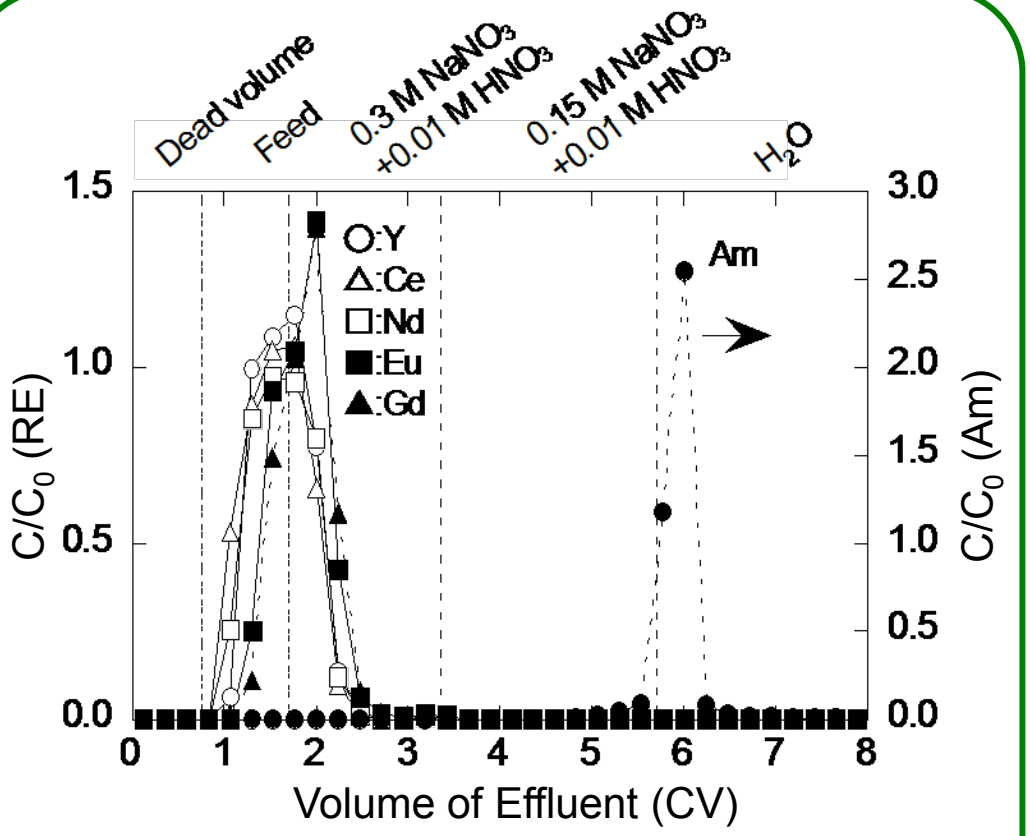
After the separation of U, Pu, Np





2,6-bis(1,2,4-triazin-3yl)-pyridine

BTP has high selectivity for An(III), but quite unstable and high cost.



Am/RE separation by nBu-BTP column

Column：10 mmϕ×260 mmH; Flow rate：1 cm³/min; 25°C

Y.-Z. Wei, et al., J. Alloys & Compounds, 374, 447 (2004).

Conclusion

- Solvent extraction and extraction chromatography have mainly been investigated for the partitioning of MA at JAEA.

- The selection of the extractant is an essential point to achieve the selective separation of An(III) in both cases.

- A large number of compounds have been synthesized and tested, but the definitive one is not found yet from the viewpoint of the engineering level.

- The efforts to develop and improve the innovative extractants should be continued to achieve the partitioning process of MA, especially for the separation of An(III) from RE.