News on Radioanalysis & Decontamination

vUGM - 24/11/2020

vCARM - NPL (UK)

Aude Bombard

TRISKEM
Expertise in Separation Chemistry

Overview

Radioanalysis

- Fe(III) separation/determination using TK400, ZR or TK201
- TK202
- TK TcScint
- TK300
- Rapid screening methods

Decontamination

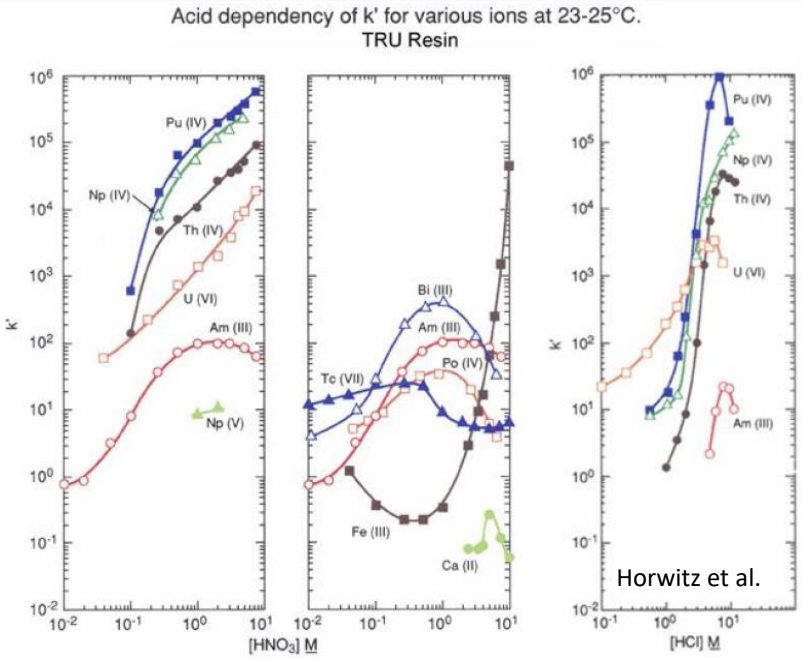
- Cs Resins

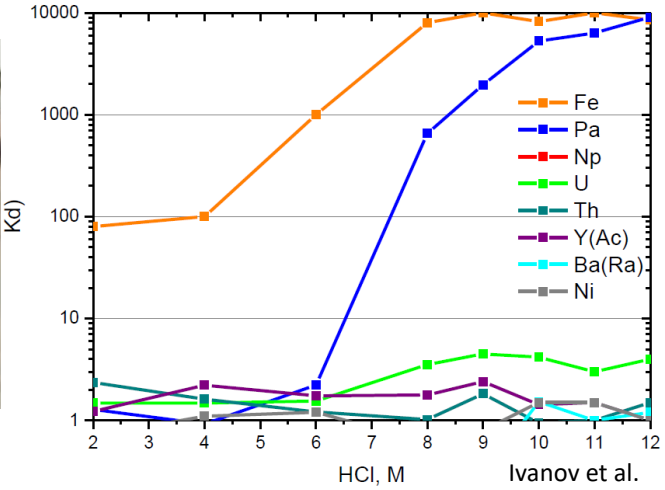
TK201-TK400 Resins
Fe separation

- TRU resin used for Fe(III) separation
  - Fe(III) fixed from 5-8M HNO_3
  - Capacity: ~ 2.5mg Fe/2ml TRU
  - TK400 followed by ZR or TK201 tested as Fe separation alternative

- TK400 => long chain alcohol based
  - Good Fe retention in high HCl concentrations (Ivanov, TKI UGM 2018)
  - Minimum capacity established @ about 20 mg Fe/ml resin in 9M HCl with a load solution of 10mg Fe/ml

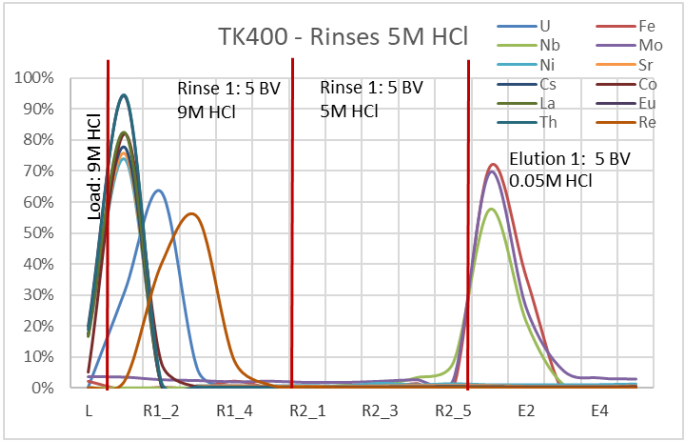
=> New perspective/options for Fe separation

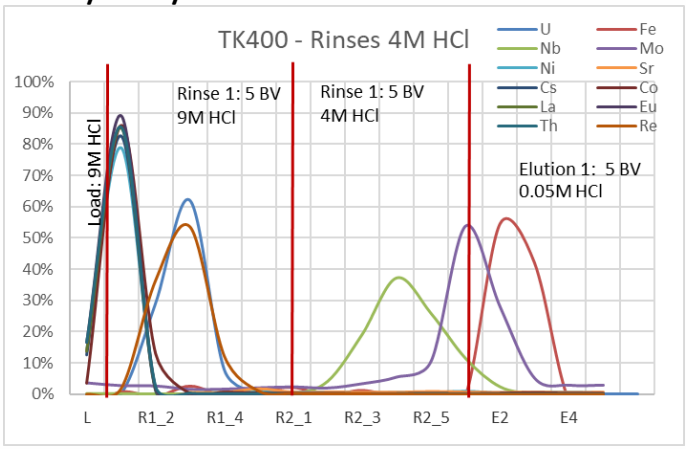




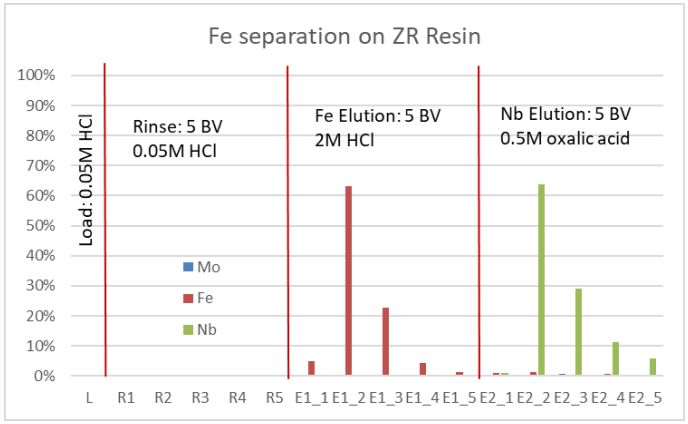
Fe/Mo/Nb separation

1/ separation from actinides on TK400 in 9M HCl => Fe/Mo/Nb co-eluted

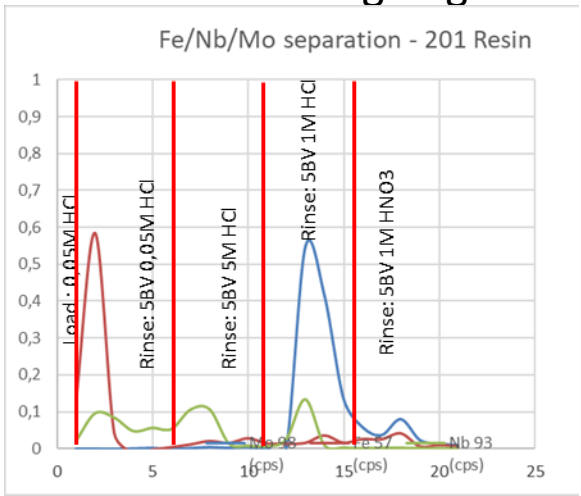




2/ Fe/Mo/Nb separation: tests on ZR and TK201 resins undergoing



More concentrated ox. acid solution needed for Mo elution

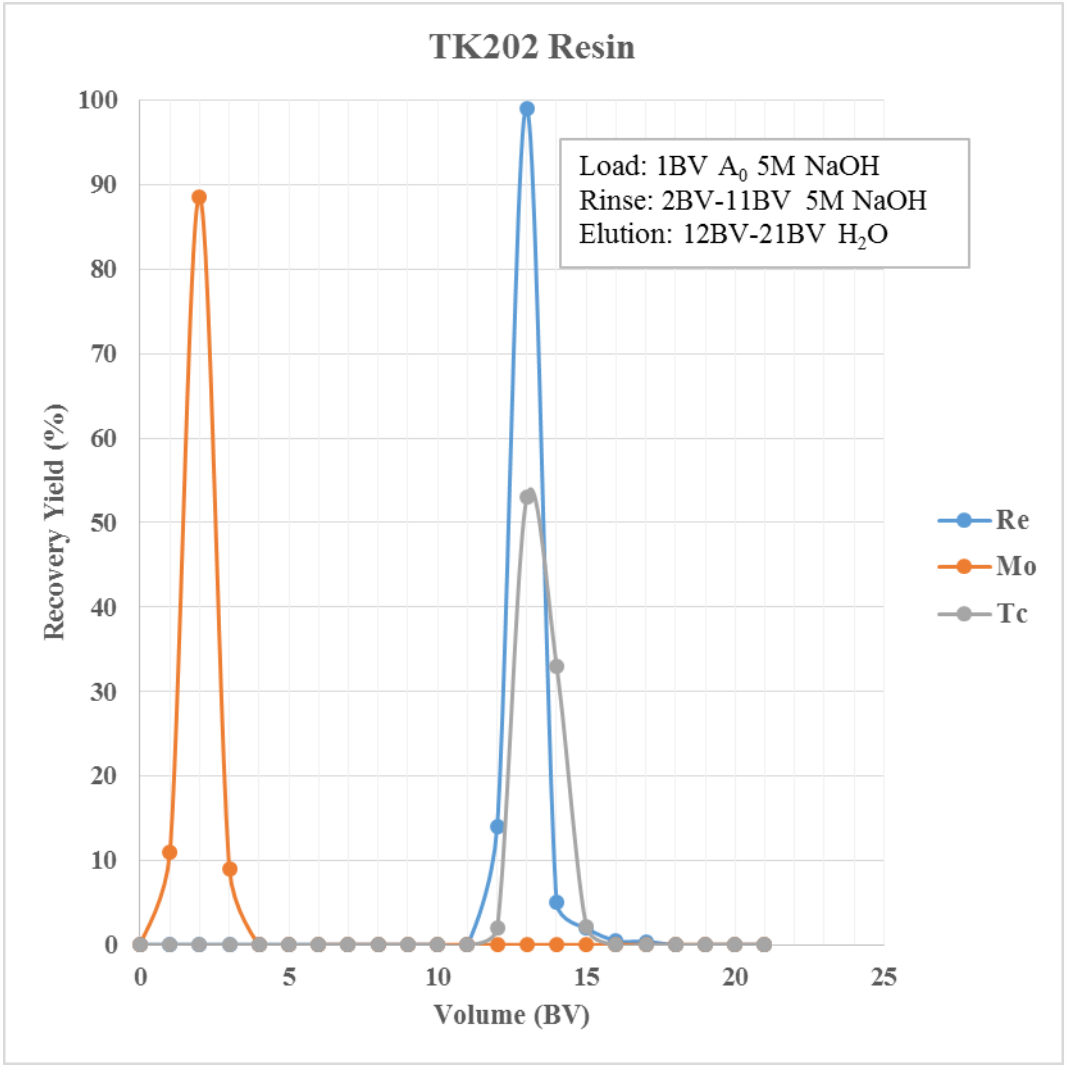


Fe eluted first, Mo eluted in 1M HCl; Nb => probably memory effects => method to be improved

Developments for Tc-99 separation

- Tc-99 (difficult to measure – DTM Radionuclide) – 100% beta emitter
- Interest in decommissioning and radioactive waste management and in Nuclear medecine (see presentation of I. Cieszykowska)
  - TEVA
  - TK201
  - TK202 => possibility to use diluted alkaline fusion (to 5M NaOH) of decom matrix for direct load on resin
  - TK Tc-SCINT

TK202 Resin



- Based on Polyethylene Glycol

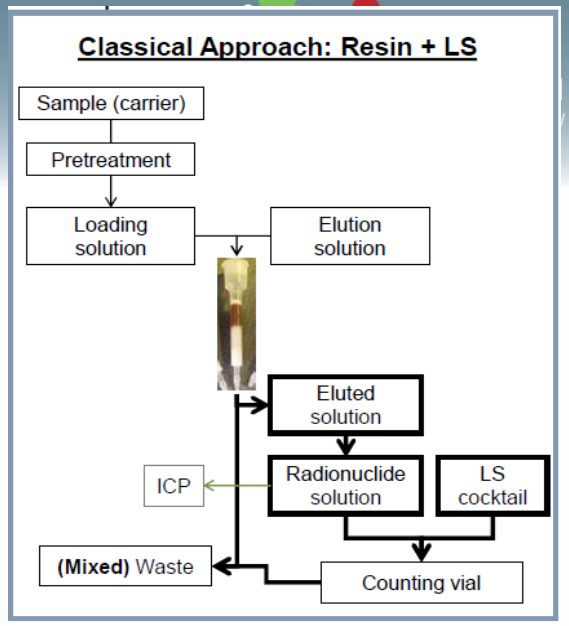
(PEG) grafted on inert support

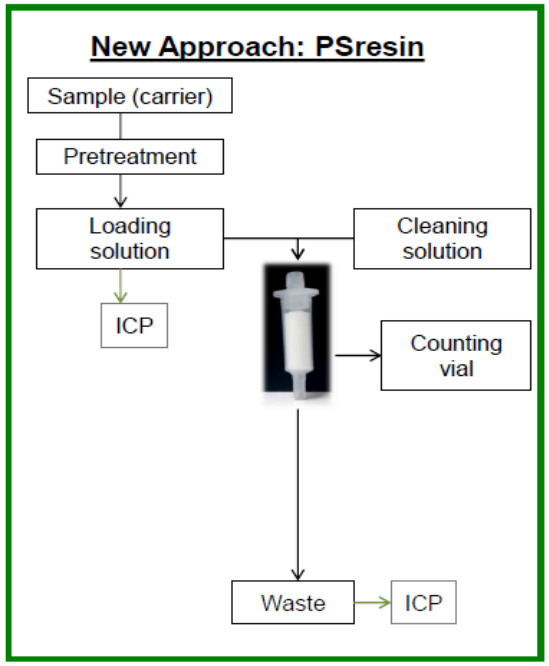
- Exchange from rich PEG phase to poor PEG phase based on
  - salting out effect due to 5M NaOH medium in our case
  - ability of salt to easily dissociates and break hydrogen bonds

- Tests show Re-Tc have similar behaviour in tested conditions
- Clean separation of Re-Tc and recovery in 5BV H2O

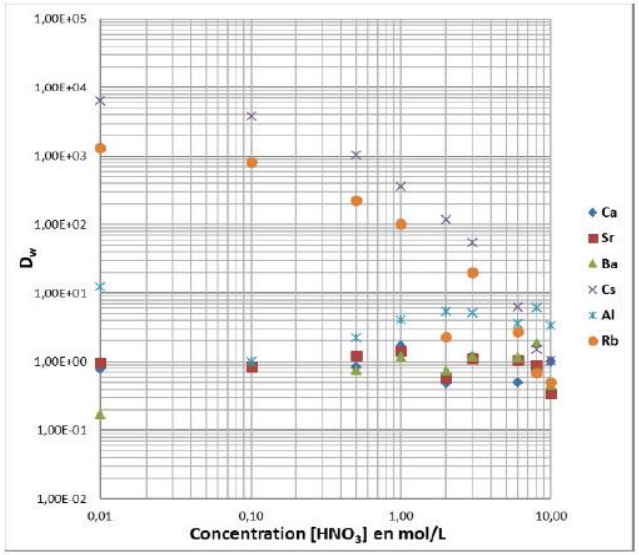
TK TcScint

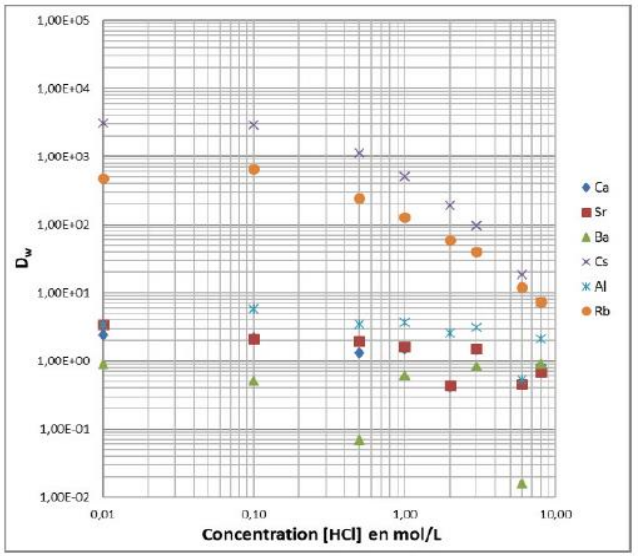
- Scintillating Resins (PSm)
- Developped by Uni Barcelona (Garcia)
- « TK ELScint » range of products
- First: « TK TcScint »
  - Similar to TEVA
- Plastic scintillator beads impregnated with selective extractants
- Direct measurement of cartridges after loading on LS counter
- Environmental.decommissioing monitoring => Tc-99 by LSC
- Chemical yield preferably via Re/ICP-MS in effluents
- Production of TK TcScint @ TKI





TK300





- Resin for Cs and/or Rb separation (e.g. from Ba, Sr) prior to ICP-MS determination
- Primary test show good Cs-Rb retention/separation from 0,01M to 1M H^+ from other matrix elements
- Initial testing showed reduced capacity

=> Improvement on the uptake capacity under testing

Rapid methods

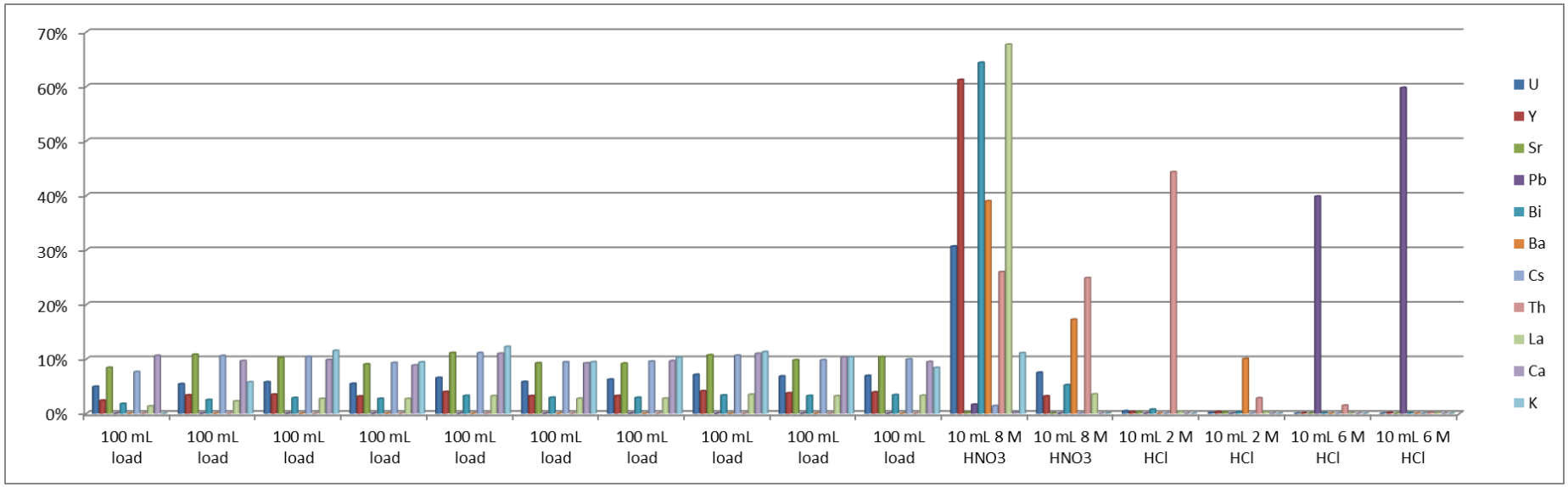
- Resins to be transposed into fast methods for screening
  - Sticks « pH paper-type » but for radioactivity (see P. Warwick presentation)
  - Membranes/discs to ease water testing
    - Tested with TK100/1 resins for Sr/Pb
    - Direct load of Sr, Pb, Ra (TK100) or Pb (TK101) from water samples
    - ➢ Presentation S. Wagner

On-going: extractive disk

- Higher flow rates (up to 100 mL/min)
- Rinsing steps to be adapted
- Direct LSC measurement of discs
  - Sample load and rinse (incl. additional rinse with water to remove trace acid)
  - Drying with vacuum
  - Transfer disc in LSC vial
  - Addition of 2 mL water and 16 mL LSC cocktail (ProSafe HC+)
- For GPC
  - Depending on disc material direct measurement might be possible
  - Otherwise elution / precipitation

TK101 Resin

- 1L surface sample, pH 2, multi-element solution (up to 5 L possible)
- 100 mL steps, 5 – 10 mL/min



- Most other elements during load or rinse with 8M HNO_3
- Th and trace Ba removed in 2M HCl

Decontamination: CS Resins

- Internalisation of AMP-PAN and KNiFC-PAN resins production at Triskem (Developed by Sebesta et al. (CVUT) => knowledge transfer)

	AMP-PAN	KNiFC-PAN
% active component	75 %	
density	~0,75 g/ml	
Capacity wet resin (mg Cs/ml resin)	11 +/- 1	31 +/- 1

- Typical analytical applications:
  - Low level Cs-134/7 determination of water samples by gamma spectrometry => bulk, columns, cartridges (presentation of M. Vasile in the session)
  - Isotopic ratio Cs-135/7 determination by ICP-MS (Zhu et al., May 2020, DOI: 10.1021/acs.analchem.0c01153 – 200ml seawater on 2ml resin)
  - Removal of high levels of Cs-137 before MS => safeguards

Decontamination: CS Resins

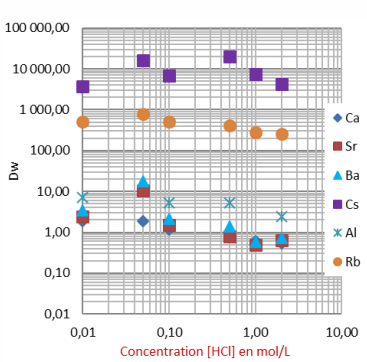
- Cs-137 decontamination of contaminated effluents => bulk, large quantities and particle sizes
  - Production larger quantities of AMP-PAN resin in 800-1200µm => 100kg produced over a week
- Possibility to extent the production tool to other semi-industrial up to industrial applications
- Part of the CLIPS structuring project
  - Customised resins / solutions and R&D contract for decontamination of effluents => radionuclides, heavy metals, pollutants…
  - Open to Collaborate for new developments and/or commercialisation

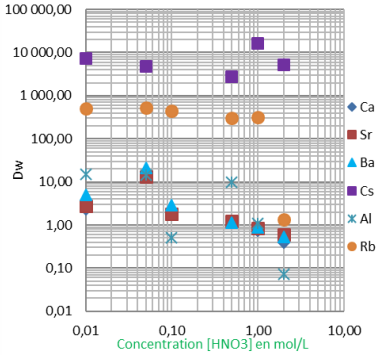
Park et al.

C.L.I.P.S. 2020

- Platform technology
  - Control/choice of wide range of selectivities/pore size/diameter
  - High content of inorganic compounds (up to ~85%)
  - Variety of inorganic compounds embedded in organic matrix under development:

    AMP & KNiFC for Cs, SbO for Sr/Y, ZrP for Sr, TiO for actinides and activation products, FeO for Se, CeO_2 or SnO_2 for Ge, $NaBiO_3$ for Am/Cm separation, MnO_2 for Ra,…





AMP-PAN selectivity in various concentrations of HNO_3/HCl

  - Possibility to use organic compounds embedded in organic matrix (HDEHP, DGA)
- Range of PAN based resins (other polymers possible depending on pH)

- Other developments done for nuclear medecine/radiopharmacy will be presented later on in this UGM

Thank you for your attention!

information @ www.triskem.com

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