The HADES Facility for High Activity Decommissioning Engineering & Science: part of the UK National Nuclear User Facility

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Introduction

Research and innovation is key to delivering UK Government's civil nuclear energy policy, in particular to accelerate reduction in the hazard, timescale and cost of legacy decommissioning and geological disposal of radioactive wastes. To address this strategic need, the Engineering & Physical Science Research Council and University of Sheffield, announced the investment of £1M to establish the High Activity Decommissioning Engineering & Science (HADES) Facility at the University of Sheffield, as part of the National Nuclear User Facility network. This will deliver the first capability in the UK academic sector for working with weighable quantities of transuranic materials including small quantities of real radioactive wastes and accurate spatially resolved microchemical analysis of radiologic materials.

The HADES Facility

- 380m^2 of state of the art radiochemistry laboratories
- Supervised Areas throughout Facility for low hazard work: kBq nat. U/Th
- Controlled Areas for low inventory work: 100 kBq nat. U/Th; MBq ^{99}Tc; 10 kBq other β,γ nuclides
- Restricted Controlled Area (60m^2) for high inventory/per experiment: 10 MBq of nat. U/Th; 5 MBq of mixed β,γ nuclides

Case Study: MOD IX Resin

Spent ion exchange resins (SIERS) in the UK are problematic wastes with suboptimal disposal routes. One approach for conditioning SIERS is thermal treatment using suitable glass forming additives, yielding a passively safe glass or slag product.

- The conditioning of a SIER from a UK waste producer was investigated. The resin contained a 1:1 mixture of cation:anion SIER with an EDTA complexant.
- Trials were undertaken on 10-40g scale. The resin was dried at 90°C and up to 50 wt.% real resin (dewatered) was mixed with glass frit (G73) in an alumina crucible and ramped to 1000-1100°C for 8h.
- Contact dose rate (150 mSv h^{-1}) of the resin (^{60}Co) required lead shielding for manipulation, and used a purpose-built tube furnace with a scrubber and filter to determine any radionuclide evolution.
- Analysis revealed the complete destruction of the resin feed into a vitrified material with minor separation of a sulphate salt phase.
- Further investigation determined up to 80 wt.% dewatered resin could produce a slag-like material with complete resin destruction

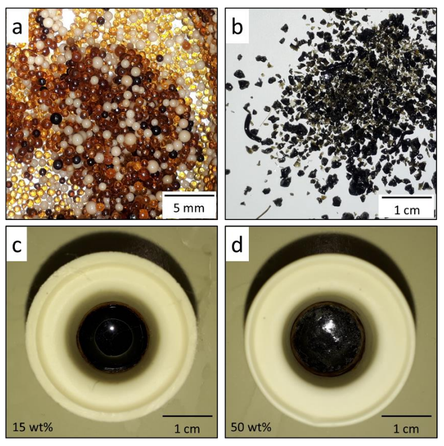


Figure 1: a) Real spent ion exchange resin material; **b)** G73 glass frit; **c)** 15 wt.% and **d)** 50 wt.% vitrified products produced from real spent ion exchange resin (on de-watered basis)

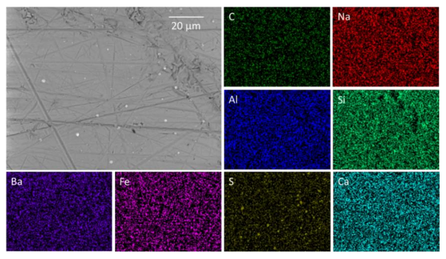


Figure 2: SEM/EDX acquired from a representative area of the vitrified material obtained from thermal treatment of 50 wt.% real spent ion exchange resin with G73 glass (Figure 1d)

Materials handling

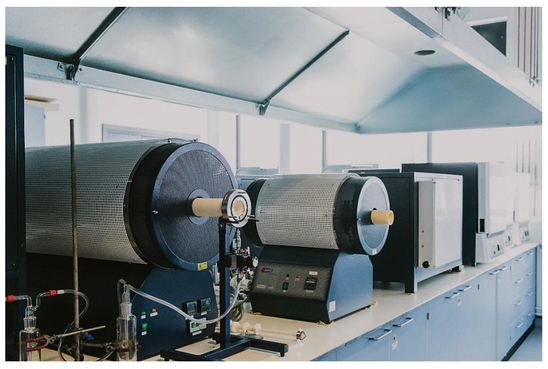
Negative pressure gloveboxes

Microscopy

Scanning electron microscope

Synthesis and processing

Planetary mill

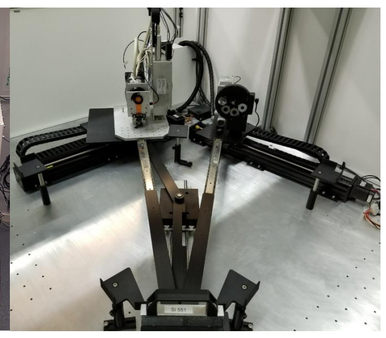


Suite of high temperature furnaces

Hot isostatic press

Diffraction and spectroscopy

D2 Phaser (left) X'Pert Pro (right) diffractometers



EasyXAFS 100 spectrometer

X-ray fluorescence

XRF Bead Maker

Gamma spectrometer

Chemical and radiochemical analysis

Inductively coupled plasma -OES (left) -MS (right)

Liquid scintillation counter

Ion chromatography

Suite of ovens for durability studies

Conclusions

- Investment by the University of Sheffield, UK Government, and EPSRC has established state of the art capability for handling high inventories of radiological materials to facilitate laboratory scale investigation of waste immobilisation technologies, characterisation of conceptual products, and evaluation of waste form disposability.
- The HADES Facility provides unique capability within the UK academic landscape, including: handling of weighable quantities of ^{99}Tc and transuranics; quantitative electron probe microanalysis of radioactive materials; hot isostatic pressing of radioactive materials; laboratory based X-ray absorption and emission spectroscopy.
- The HADES facility and equipment are open to external access via the arrangements of the UK National Nuclear User Facility and Henry Royce Institute.

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Reference. *The HADES Facility for High Activity Decommissioning Engineering & Science: part of the UK National Nuclear User Facility*, N.C. Hyatt, C.L. Corkhill, M.C. Stennett, R.J. Hand, L.J. Gardner, *IOP Conference Series: Materials Science and Engineering*, 818, 012022, 2020. https://doi.org/10.1088/1757-899X/818/1/012022.

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