NEWSLETTER Edition 2
Winter 2020

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Hard times for everyone, as well as for TRANSCEND

From the start of the project in late 2018, our researchers made good technical progress, with all scheduled consortium Management Board and Industrial Advisory Group meetings held in addition to our successful technical Annual and Theme Meetings. Our website was put in place together with a social media presence, a newsletter issued, and Industry Roadshows were held to broaden engagement with the consortium. Two of our investigators were also seconded to BEIS, allowing our subject matter experts to provide input to teams working on nuclear waste policy and risk-based disposability, as well as providing the investigators with the opportunity to gain policy experience. Work on a public outreach activity on the social and ethical dimensions of nuclear waste management was progressing well, as was promotion of the project via short documentary videos, in addition to other impact activities.

And then of course along came covid-19, and the impact on research was both rapid and dramatic, with the pandemic curtailing a great deal of our research as laboratories were shut down and pressures on IT departments due to the move to online teaching affecting both experimental and mathematical modelling work alike. Some work had to be paused, and indeed some research fellows were furloughed, with access to university laboratories and other active facilities severely impacted. These issues will have both short- and long-term effects on the project, and we are grateful to the EPSRC who recognised these impacts and allowed a 12 month no-cost extension to the project to allow us time to meet our original objectives.

All organisations involved in the consortium implemented strategies to mitigate the long-term impact of the disruptions associated with the pandemic. Management of the consortium moved online, as did our recent technical Theme Meeting. Discussions with our researchers ahead of that meeting at the beginning of December indicated that whilst some are progressing reasonably on target, others judge themselves to be more than 6 months behind where they had hoped to be, with everything else in between. Fortunately, as the situation in universities eases and researchers return to their laboratories, the technical work on the project is beginning to gather pace. However, and in line with the findings of a survey by Vitae on behalf of BEIS [1] , although returning to work with social distancing will allow research to continue again, under the present circumstances this will not allow capacity to increase to pre-lockdown levels. Respondents to the survey also suggested that help needed to be provided in terms of: improving access to facilities; encouraging collaboration amongst research groups to make the most of limited access to facilities; providing extensions to projects and funding; and making concessions for any reduction in research quality. Every effort is being made by the consortium to address the first and second points, and the third has been addressed by the grant extension noted above. The final point remains an issue, however, although hopefully with just under 3 years to run, our researchers will be able to make up for lost time and deliver the international leading science and engineering outputs, and impactful research, originally envisaged.

In the meantime we all put our hope in the vaccines being rolled-out across the globe which will hopefully, with better testing and treatments, see a return to normal working arrangements this year. Until then, please follow the guidance on staying safe and social distancing, and we look forward to welcoming you back to our meetings in person at some point in 2021.

Mike Fairweather

(M.Fairweather@leeds.ac.uk)

1. https://www.vitae.ac.uk/news/vitae-news-2020/impact-of-lockdown-on-researchers-in-uk

TRANSCEND Theme meetings 2020

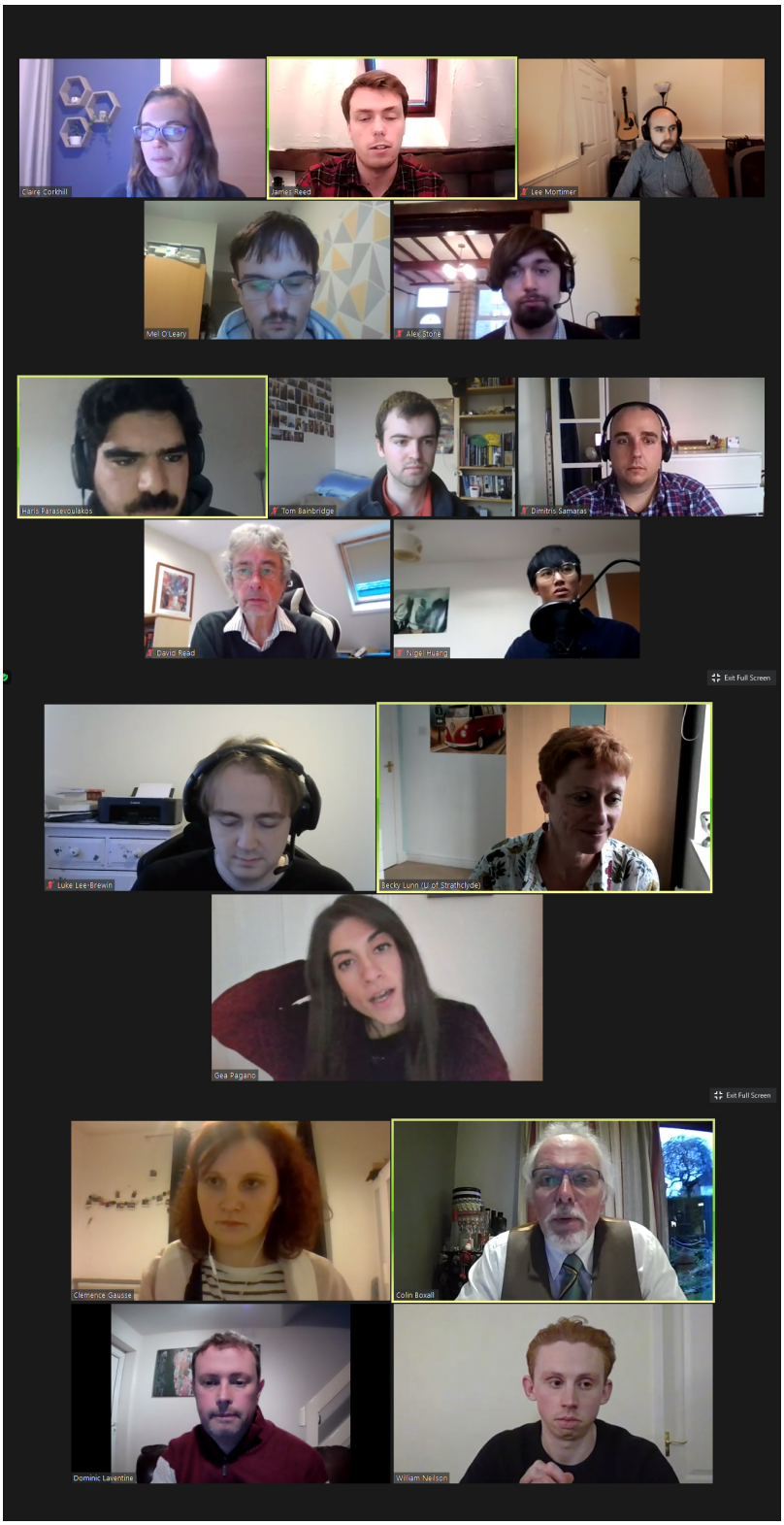
This year's Theme meetings were held on 2nd & 3rd December 2020 as part of a virtual joint conference with the Nuclear Waste and Decommissioning Forum (NWDRF) and the NDA bursary students.

Over 300 delegates registered to learn about the latest research and developments in the areas of Nuclear Materials, Spent Fuels, Integrated Waste Management, and Site Remediation and Decommissioning.

The parallel sessions running over the two days provided a variety of presentations and generated some interesting questions and input from the audience.

Day 1 kicked off with overview presentations from Sarah Bibby (Sellafield) on Post Operational Clean Out (IWM theme) and a joint presentation by Sandra Clarke (Sellafield) and David Hambley (NNL) on the Management of Spent Fuel in the UK (Spent Fuel theme). These were followed by more focussed presentations from industry, student and academic researchers.

Day 2 followed a similar format with opening presentations by Roxana O'Hara (DSRL) on Decommissioning of a Fuel Reprocessing Facility (Site Remediation & Decommissioning theme) and Rob Barnard (Sellafield) with an Overview on Special Nuclear Materials Packages (Nuclear Materials theme).



TRANSCEND/NDA/NWDRF
Virtual Conference
2-3 December 2020

TRANSCEND

NDA

UKRI Engineering and Physical Sciences Research Council

TRANSCEND at WM2020, Phoenix, Arizona

TRANSCEND organised a dedicated technical session at WM2020 held from 8th – 12th March 2020 in Phoenix, Arizona. This is the leading international conference for the management of radioactive waste and related topics. The session consisted of seven presentations providing an overview of the programme, the four themes, an industry perspective of TRANSCEND and a case study of where our earlier research is making an impact. The good attendance at the technical session and the networking social held afterwards showed that there is significant interest in our research programme. TRANSCEND associated presentations were also well received in other sessions.

Thanks go to Professor Ian Pegg (Catholic University of America) and Laurie Judd (Longenecker & Associates) for chairing the session.

We are extremely grateful to Longenecker & Associates for their generous sponsorship of the networking social.

Waste Management 2022

6 - 10th March 2022, Phoenix, Arizona

The TRANSCEND consortium plans to have a dedicated session at WM2022 - the leading international conference for the management of radioactive waste and related topics.

For 2022 the United Kingdom will be the featured country

Active Research Fund

The TRANSCEND consortium has a £500k Active Research Fund (ARF) from EPSRC, NDA and RWM. This is to support access to university and national research facilities to undertake research involving the use of radioactive materials or sources, or the procurement of radioisotopes or small equipment items to enable handling, transport, or other work with radioactive materials.

There is an continuous call open for proposals. For the EPSRC funds each proposal is reviewed by two members of the Management Board. Applications to the NDA and RWM are inititially assessed by the respective programme managers with the reviews completed by the Management Board members.

Enquiries about the fund should be addressed to Professor Neil Hyatt n.c.hyatt@sheffield.ac.uk.

To date the following projects have been successful in securing awards from these funds:

Fabrication and characterisation of cold press and sintered ceramic wasteforms incorporating plutonium

Neil Hyatt and Lewis Blackburn
University of Sheffield

This project will achieve preparation and characterisation of zirconolite ceramic wasteform, incorporating plutonium oxide at the Australian Nuclear Science & Technology Organisation (ANSTO). The project will validate ceramic formulations developed for plutonium immobilisation at the University of Sheffield and NNL. Lewis Blackburn will be seconded to ANSTO for ca. 3 months to assist, as far as possible, in the fabrication and characterisation of the materials. The project will provide vital early validation of the UK formulation development for immobilisation and disposal of the plutonium stockpile, if required.

Small equipment grant to facilitate the analysis of mm-scale spent-fuel particles using standard laboratory instrumentation

Haris Paraskevoulakos, Peter Martin and Tom Scott
University of Bristol

The analysis of nuclear material represents a large challenge due to the high levels of dangerous ionising radioactivity that it emits. This consequently limits the number of analytical facilities around the UK (and world) that are able to handle this material and understand its properties, behaviour and future requirements for safe long-term storage under strictly controlled conditions at locations around the UK. To facilitate the higher-resolution analysis of small sub-samples of this highly active material at the growing number of increasingly capable university and non-dedicated laboratories, this project will seek to develop a radiation shielded transport and analytical instrument compatible vessel (with vacuum storage). Resultantly, it will be possible to undertake unprecedented (sub)sample analysis at facilities where cutting-edge equipment resides, away from the limited number of dedicated radiation labs, where such more advanced instruments do not exist. The understanding gained during this project will be crucial in underpinning how nuclear material behaves, both under storage conditions and in the environment – informing national strategy and best practice for decades to come.

Upgrade and enhancement of laboratory XAS capability for radioactive sample analysis

Neil Hyatt
University of Sheffield

This project will procure, install, commission and utilise small equipment items to upgrade the unique laboratory XAS recently established at the University of Sheffield. The equipment will enhance the capability for working with radioactive materials, in particular, enabling the investigation of local environment and oxidation state of Pu surrogate (U, Th, Ce) and charge compensating species (Fe, Cr, Ni), respectively, within ceramic wasteforms. This will enable characterisation of such ceramics without the requirement for access to a synchrotron radiation facility and support the work of the wider TRANSCEND consortium through collaborative access to the facility.

Small scale 242-Pu validation of ceramic wasteforms

Neil Hyatt
University of Sheffield

This project will procure, characterise and utilise an inventory of 242PuO2 to enable Pu validation studies of ceramic formulation for the UK plutonium stockpile. The inventory will support the research of the EPSRC sponsored PDRA and NDA sponsored PhD students.

Small equipment grant for sample preparation for multimodal microfocus synchrotron X-ray analysis

Claire Corkhill, Clemence Gausse
and Clare Thorpe
University of Sheffield

This project will purchase, install and utilise a thin sectioning system to enable the preparation of radioactive element-containing samples of vitrified thermal treatment products by micro-focus analysis techniques at user facilities. The equipment will enhance the capability for working with radioactive materials, in particular, enabling the investigation Cs, U, Th distribution and partitioning within thermally-treated vitreous wastes and other materials of interest to the wider TRANSCEND consortium.

Observing gas generation by the irradiation of wetted brucite/hydromagnesite

Bruce Hanson, Matthew Jackson,
Fred Currell, Mel O'Leary, Chris Anderson
Universities of Leeds and Manchester

Currently a stockpile of spent Magnox nuclear fuel is stored under water following use prior to reprocessing. Some of this material will not be reprocessed and has no existing disposal route, so will remain in wet storage for longer than planned. In storage the fuel will undergo corrosion which can result in hazards and unwanted expense down the line. A potential solution to this issue is drying the wet fuel and holding in dry storage for the interim period, prior to construction of an underground disposal facility. To understand how previously wetted and corroded Magnox fuel will behave in storage, it is important to observe the interactions between residual water and the fuel in a radioactive environment. Funding provided by TRANSCEND has enabled research into this area as part of a PhD at the University of Leeds, giving a valuable insight into a process that would not be viable to investigate otherwise, providing better technical value to the industry whilst improving university collaboration.

TRANSCEND Industry partners

TRANSCEND has eight industry partners. Here some of our partners explain the importance and benefits of their involvement in the consortium.

Nuclear Decommissioning Authority

The NDA's mission is to clean up the UK's earliest nuclear sites safely, securely and cost-effectively with care for people and the environment. That mission is going to take several decades to complete. Over that time we need to ensure that we have the appropriate skills and capability available to us and our supply chain to tackle the technical challenges we'll face. This is important at all levels of the challenge, but especially so when it comes to subject matter expertise.

In setting the strategy for tacking the UK's nuclear legacy, NDA have identified 4 key themes; Spent Fuels, Nuclear Materials, Integrated Waste Management and Site Decommissioning and Remediation. It's no accident that the TRANSCEND research themes align with the NDA's strategic challenges. TRANSCEND will provide a wealth of highly skilled researchers with a strong background knowledge of nuclear decommissioning who can go on to become the next generation of technical leaders.

The innovative research taking place in TRANSCEND builds upon previous consortium projects, DIAMOND and DISTINCTIVE, in which NDA also sponsored research. This constant development of the knowledge base is essential for driving improvements in efficiency to the mission. A strong knowledge exchange network has been created between the academic experts and industry practitioners through these consortia and this too is a key driver for continued NDA support. That network is crucial for converting research into impact and TRANSCEND excels at providing that exchange platform.

Nuclear Technologies

TUV SUD Nuclear Technologies Division

For almost a decade TUV SUD Nuclear Technologies Division has provided technical support to the NDA organisation's Nuclear Materials and Spent Fuel areas. Our long-lasting relationship has included support to the strategic definition of the UK decommissioning mission and development of technical means aimed at delivering its goals. To effectively and safely meet these goals R&D progress is a critical enabler which means that keeping up to date with the latest research and interacting with research consortiums such as TRANSCEND (and its predecessors) are crucial parts of our work.

Being part of research consortiums has also provided an opportunity for the TUV SUD Nuclear Technologies Division to invest in new talent, where we have provided secondments and hired alumni from DIAMOND and the DISTINCTIVE consortiums. By way of an example, recent additions to the team are Darryl Messer and Jamie Southworth. Both have been welcomed into our team after the completion of their PhD studies on radiolytic investigations in conditions relevant to the long-term management of the UK civil plutonium stocks.

Moving forward, our expectation is to continue to offer a bridge between university research and industrial opportunities for TRANSCEND researchers who would wish to progress a career in the nuclear decommissioning field.

If you would like further information on our involvement with NDA or TRANSCEND please feel free to contact carlos.delafontaine@tuvsud.com

Sellafield Ltd

Sellafield has been nearly 80 years in the making. A pioneer for the UK's nuclear industry, it supported national defence, generated electricity for nearly half a century, and developed the ability to safely manage nuclear waste.

Sellafield Ltd are responsible for the safe and secure operation and clean-up of the Sellafield nuclear site. From cleaning-up the country's highest nuclear risks and hazards to safeguarding nuclear fuel, materials and waste, our mission is nationally important.

The mission is complex and will take many decades to complete. It is this complexity, and often unique challenges, that makes academic research such a valuable contribution to the work we do. The value is realised through the research and development of more optimal techniques, methods and technologies, in underpinning our decision making, and of course in the development of the next generation of highly skilled nuclear professionals.

All of the four TRANSCEND themes contribute to the Sellafield mission, and the consortium provides excellent routes and access to some of the UKs foremost experts. This includes projects relevant to the entire lifecycle of Sellafield plants:

- Improvement of plant operations; such as investigations into novel ion exchangers for effluent treatment, the scientific underpinning for long term storage of nuclear materials and spent fuel and new monitoring techniques asset care
- New and improved methods of waste treatment and better understanding of those currently used
- Novel decontamination and decommissioning techniques
- Focus on characterising and mitigating contaminated land, so Sellafield plants can reach their end states

UK National Nuclear Laboratory

The UK's National Nuclear Laboratory (NNL) has been integral to the UK strategy in the nuclear arena since the inception of the industry more than 75 years ago. We can trace our history through the research, development, commissioning and operations that underpin nuclear plants throughout this time period. NNL's role encompasses all aspects of the fuel cycle from enrichment and fuel production through operations and final waste disposal.

This provision of robust science is accompanied by a detailed understanding, developed through decades of industrial experience of the key multi-disciplinary factors which must be considered when developing innovative solutions to technical challenges, that can be applied in industry.

NNL is the authoritative voice in Britain and beyond for technological development and innovation in civil nuclear power. Our unparalleled understanding of the nuclear science, challenges and opportunities makes us an unrivalled authority and partner in the field, providing experts, innovative technologies, and access to cutting-edge facilities to organisations in the UK and globally.

Our workforce has a collective 10,000 years of industry experience including dozens of recognised subject matter experts. Through our strategic collaborations with the best in the world – in industry and academia - we harness potential technologies and translate them into industry-ready solutions. This pioneering approach enables us to spearhead international improvement and technological progress.

The NNL role managing TRANSCEND for the industry is an example of this strategic collaboration. Working with industrial and academic partners, the consortium is developing innovative solutions to challenges in industry, with the potential for industrial deployment. Equally important is that TRANSECND is training future Subject Matter Experts, during their PhD and Post-doctoral projects, as a key feed into the skills pipelines for all aspects of the nuclear industry.

Wish Lists

For this edition of the newsletter, we asked our researchers to write a project "wish list". Some have taken the opportunity to think about what they hope to achieve by the end of their project, and some have focused on their current needs, highlighting where help is required.

If a researcher has listed something that you and/or your organisation can help with, we strongly encourage you to get in touch. Engagement and collaboration (academic and industrial) remains a priority of the consortium. Please email Dr Lois S. Tovey (l.tovey@leeds.ac.uk) in the first instance.

Nanotechnology for effluent treatment, radionuclide assay and repair of ageing facilities

Gurpreet Singh,
PDRA,
Imperial College

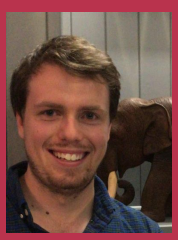
Wish list

- To conduct ion-exchange/adsorption experiments on the active effluent streams and legacy waste ponds.
- To conduct the cost-benefit analysis of the exchanger materials vs magnetic nano-particles for future implications

Progress

- Magnetite synthesis at Imperial has been performed for particle sizes 10nm to 50nm using both thermal decomposition and precipitation. Current work is ongoing for optimising the precipitation routes to achieve mono-dispersity.
- Functionalisation studies using phosphate groups are also under-way currently and is targeted primarily at Uranium adsorption, however further heavy metals, actinides and lanthanides will be targeted too.

Scoping Studies of New Ion Exchange Materials



James Reed,
PhD,
University of Birmingham

Wish list

- Access to an active testing facility for ion exchange experiments.
- Further characterisation of storage ponds at Sellafield.
- High resolution microscopy studies to determine nature of composite materials.

Progress

- Demonstrated the transformation of 3 natural zeolites into alternative phases.
- Found that composites can be obtained through partially completed transformations.
- Demonstrated effects of these phase changes on the ion exchange selectivity's of these materials.
- hown that composite materials can have promising selectivity profiles.
- Investigated the mechanism of transformation through use of alternative reagents.
- Explored lower cost, more scalable routes to these materials.

Particle-laden flow characterisation and prediction

Lee Mortimer,
PDRA,
University of Leeds

Wish list

- Obtain more computational resources such as devoted compute nodes on the HPC facilities at Leeds (ARC), as well as personal workstations.
- Develop collaborations with local, national and international researchers to network, share ideas and build connections.
- Attend internal ARC training on advanced computing topics such as 'GPU programming with CUDA' and 'Cloud computing and big data analysis'.

Progress

- Behavioural modification techniques have been studied in the context of binary particle interactions, with the effects of modifying properties such as ionic strength, temperature and Hamaker constant being determined.
- A novel particle and polymer-laden flow technique based on the finitely extensible non-linear elastic dumbbell model has been developed, implemented and validated.
- The technique has been used to demonstrate stretching in shear flows, polymer-based flow modulation as well as to study polymeric drag reduction in turbulent channel flows.
- The model has also been extended to account for polymer-particle interaction, and is being used to provide insight into the potential and feasibility of using polymer additives to tune agglomeration and dispersion properties for nuclear waste transport flows.

Radiation induced changes in effluents/ sludge

Mel O'Leary
PDRA,
University of Manchester

Wish list

- Extra 6 months in lab to make up for SARS_COV2 pandemic.
- Award of SMORES active research fund grant.

Progress

- Paper being submitted to Small.
- Detected radiation induced change in electrical properties of sludge particles.Developed automatic computer method for bubble detection.

Simulation of behavioural modification effects in suspension waste pipe flows.

Bisrat Wolde,
PhD,
University of Leeds

Wish list

- Facility of high-performance computing environments for development and testing.
- Publishing a paper.
-

Progress

- Single and multi-phase direct numerical simulation carried out in a fully developed turbulent pipe flow at two different turbulent bulk Reynolds number, Re_b=5300 and 11,700.The predictions have been validated and compared with literature simulations and experimental datasets.
- The present work is in good agreement with literature results.
- To investigate the bulk behaviour of high concentration dispersions, a Lagrangian particle tracker implemented to model large quantities of dispersed solids.
- The behavioural modification effects to be studied includes the change in temperature, ionic strength, polymers and pH of the liquid phase.

Advanced Ultrasonic Characterisation of Slurry Flows

Joe Hartley,
PhD,
University of Leeds

Characterisation and safe transport of radioactive material as waste suspension flows is of great importance to the nuclear sector. Retrieval of legacy waste sludge from ponds to interim storage via pipeline is not currently optimised because of a lack of relevant design data. This project seeks to understand and overcome these issues through the development of an online acoustic back-scatter technique for the remote characterisation of particle size and concentration. In addition to understanding the effect of polymer additives to modify slurry characteristics that enable safe and efficient slurry transport.

Wish list

- Construct a small diameter, variable shear cell (to represent pipeline conditions).
- Characterise the ultrasonic backscatter, attenuation and speed of sound for well mixed suspensions of various inorganic and organic test materials.
- Investigate the influence of suspension aggregation on acoustic response.
- Investigate the influence of near-field interference on signal convolution.
- Develop rudimentary Machine Learning code for identifying suspension properties
-

Progress

- Covered fundamental concepts on fluid dynamics.
- Began learning Python programming language and Machine Learning fundamentals.
- Began to put together a literature review.

Simulations of Processes At and Across Nanoparticle-Water Interfaces

Ella Schaefer
PhD,
University of Manchester

Wish list

- To develop a series of simulations where energy can be directly deposited into nanoparticles (NPs), and calculate/model the energy transfer processes that occur at the NP-Water interface.
- To build a simulation for the mechanism of energy transport by excitons.
- To cultivate an integrated account of all the processes that occur at the NP-Water interface.

Progress

- Developed a simulation method of depositing radiation into a NP within a hollow water sphere, and calculating the subsequent dose deposition, using TOPAS software.
- This simulation has been run with various NP types (Au, Al2O3, Mg(OH)2 and water) at both low and high energies.
- Currently building a scorer to detect ionisations and excitations caused by electrons in water.

Durability of magnesium silicate cements

Mercedes Baxter-Chinery,
PhD,
Imperial College

Wish list

- Test the ability of the Magnesium-Silicate-Hydrate cements to immobilise Caesium-133, Strontium, and other radionuclides
- Characterise and optimise Magnesium – Silicate – Hydrate cement made from magnesium hydroxide powder
- Complete tests to determine the early property, long term durability and behaviour in various environments of Magnesium – Silicate – Hydrate cements with different magnesium sources
- Use a simulant for the brucite sludge at Sellafield to successfully produce a Magnesium – Silicate – Hydrate cement

Progress

- Reproduced the reference mixture originally optimised by Zhang (DIAMOND, 2012)Started optimising the mixture using magnesium hydroxide powder as the magnesium source
- Completed a literature review to identify potential routes for research Created an initial plan of experiments to be undertaken

Radiation effects on nuclear waste forms: How does the degree of crystallinity in a glass-ceramic affect radiation tolerance?

Tamas Zagyva,
PhD,
University of Manchester

Wish list

- I would like to do X-ray absorption spectroscopy (XANES and XAS) measurements on borosilicate glass samples containing molybdenum.
- I would like to coat glass-ceramic samples with ~ 2.5 nm carbon for EBSD measurements. (Carbon coater is unfortunately not available at Dalton Cumbrian Facility.)

Progress

- Detailed characterisation of (VTR) nuclear waste simulant glass-ceramics.
- Heat treatment experiments – better understanding of powellite crystallisation in the Ca/Zn glass matrix.
- First irradiation experiments on glass samples (and corresponding simulations).
- X-ray absorption spectroscopy measurements (further data processing is needed).

Development of sustainable substitutes for Pulversized Fly Ash in Cement and Concrete

Andrea Kozlowski
PhD,
University of Strathclyde

Wish list

- Samples of different cement formulations from different environmental conditions
- Hands on training on Strathclyde's XCT, once lab restrictions are lifted
- Characterising the physical, chemical, and mechanical properties of the substituted cements
- Understanding impact of PFA alternatives on cement properties and performance

Progress

- Good background understanding from all that reading during lockdown
- Samples on their way from LLWR (thanks!)
- Learning XCT data analysis

Characterisation of Thermally Treated Products

Daniel Parkes,
PhD,
University of Sheffield

Wish list

- Major wish is to return to the labs.
- As part of the lab return, I wish to undertake machine training and start experimental work.
- Be able to travel to field sites and collect analogue samples.

Progress

- Completed a first-year report. In the absence of any experimental data the report consisted of a literature review on the thermal treatment of Intermediate Level Waste and an initial experimental plan.
- Collected a set of thermally treated Plutonium Contaminated Material samples from Valingar. The samples are current industrial simulants that have been treated using plasma vitrification and will be sub-sampled and analysed using a variety of characterisation techniques.
- I am working with lab managers on safe methods for lab and equipment training that will hopefully facilitate a return to lab work in the near future.

Process Monitoring and Emission Control During Thermal Treatment of Nuclear Wastes

Alex Stone,
PhD,
Sheffield Hallam University

Wish list

- Visit the National Nuclear Laboratory Central lab and Sellafield site
- A new high temperature furnace for off gas measurement
- Access to industrial scale waste vitrification centres for large scale emissions testing
- Collaborations with others undertaking similar off gas treatment analysis

Progress

- Initial waste glasses produced with high waste loading especially for clinoptilolite waste simulants.
- Choice of wastes to include in study finalised
- Off gas system design finalised
- Potential collaboration to use new type of raman analysis for real time gas analysis
- Literature review and thesis progress

Understanding glass melt chemistry in thermal treatment of nuclear waste

Lucas-Jay Woodbridge
PhD,
University of Sheffield

Wish list

- Pt crucible and stirrer
- RAMAN for off-gas studies (owned by uni not lent)
- Hot cell for active Cs137 work
- Magnetic stirrer that operates under high temperatures (to stir melts that are contained in a closed stell system

Progress

- Made pristine glasses
- Made some Cs doped versions
- Pycnometer used on glasses made (density)
- Thermal analysis on glasses made
- Some RAMAN done on pristine glasses
- Waiting on respirators for work to continue (can't melt)
- Movement of kit between buildings coupled with covid also majorly held work up

Inhibiting radionuclide migration during deconstruction and decommissioning using colloidal silica grout

Gea Pagano,
PDRA
Univerity of Strathclyde

Wish list

- Obtain experimental data on CSH formation in radioactive waste containment cement mixtures treated with colloidal silica
- Access to relevant facilities at the University of Bristol to assess the feasibility of in-situ and ex-situ vitrification of grouted soils
- Access to the University of Southampton to set-up experiments to combine electro-kinetic technique with colloidal silica grouting
- Obtain experimental data on sorption/desorption properties of colloidal silica grout enriched with clay minerals to inhibit radionuclide migration

Progress

- Unconfined compression tests and tensile splitting tests on fractured, ordinary Portland cement cores carried out in the past months have shown a significant strength recovery (up to 90%) after treatment with colloidal silica, thus suggesting the formation of additional cementitious compounds. Additional cores are currently being treated with colloidal silica spiked with deuterium to perform SIMS analysis (University of Bristol) for the detection of newly-formed CSH
- A preliminary experimental plan on electro-kinetic remediation in colloidal silica grouted soils to be set-up at the University of Southampton has been agreed

Electrokinetic remediation for nuclear site decommissioning

Jamie Purkis,
PDRA,
University of Southampton

Wish list

- Adapt low-energy ex-situ electrokinetic remediation (EKR) proven on UK nuclear legacy wastes and sites;
- Develop in-situ low-energy electrokinetic fencing (for groundwater)and remediation (for soils and sediments), to limit the spread of active contaminants, and minimise soil volumes for subsequent
- treatment;
- Combine EKR with colloidal silica grouting to minimise soil
- contamination for in-situ vitrification.

Progress

- Major developments since 2009 reviewed
- In-situ precipitation of iron-rich reactive barriers studied
- EKR in organic-rich, clayey soils studied
- Examples of scaled-up EKR examined

Generally, we've assessed and shown that EKR works at the small scale, and our main objective now is helping site managers, etc., at nuclear sites being decommissioned how EKR is useful for them. We're developing a simple model that unifies complex electrochemical equations with simple things (rainfall, soil type) to show whether EKR is useful and, if so, recommend how it can clean up radionuclides trapped in contaminated soils.

Using Electrokinetics to Remove Radionuclides From Contaminated Nuclear Materials

Shaun Hemming,
PhD
University of Southampton

Wish list

- To determine how various difficult to measure radionuclides migrate through materials in need of decommissioning, using low voltage DC currents.
-
- To explore the potential of electrokinetics for capturing and removing these contaminants from media such as soils and groundwaters.

Progress

- Read through the literature
- In the process of setting up experiments/ gaining lab access to start in the new year

An advanced blind-tube monitoring instrument to improve the characterization of subsurface radioactive plumes

Soraia Elisio,
PhD,
Lancaster University

Wish list

- Access to open sources to undertake radiological testing at high dose rates (1 Gy/h).
- Access to facility to undertake sub ambient temperature, waterproofing, and vibration resistance testing.
- Distinguish bremsstrahlung photons from low energy backscattering Compton photons applying deconvolution methods.
- Build a robust blind-tube string network to undertake contamination mapping in a 3D spatial arrangement in order to characterize radioactivity underground defined in terms of strontium-90 and caesium-137, with radial depth of investigation of about 25 cm.
- Test the complete system in real environment on the existing blind-tube network and create a 3D picture of sub-surface heterogeneity within MSSS at the Sellafield site.

Progress

- Proposal submitted on Characterisation and monitoring using existing in-ground assets in collaboration with Hybrid Instruments Limited, and first stage accepted on Sellafield Game Changers.
- Design and detector components have been selected. CAD drawing of sensing probe completed and construction/ assembly underway.
- Design of the soil pipe arrangement to replicate the in-ground blind-tubes set on site. CAD drawing and selection of components completed and construction/assembly underway.
- Modelling and laboratory experiments are underway to validate the concept and calibrate a single detector in a soil pipe arrangement that replicates the in-ground blindtubes set on site.
- Clearance necessary to have access to Sellafield site and official-sensitive information underway.
- Abstract submitted for oral presentation at the 7th International Conference on Advancements in Nuclear Instrumentation Measurement Methods and their Applications (ANIMMA 2021).
- Attending the Nuclear Industry Online Radiation Detection Workshops from University of Liverpool (Nov/Dec 2020).

Predicting Gamma Dose Rates from Underground Contaminated Structures With Limited Information

Luke Lee-Brewin,
PhD,
University of Surrey

Wish list

- When the situation allows, I would like to visit the Winfrith power plant to generate my own testing set from a real contaminated structure.
- At Winfrith, my preference would be to use a HPGe detector to create a high-quality spectrum of the pipe containing as much information as possible to validate the effectiveness of my methods against.
- Finally, I would like to build a scintillator with a mechanism to easily change the crystal to test the effects of different crystals in my wavelet program.

Progress

- Implemented a method of detecting the location of low signal to noise ratio photo-peaks using wavelet analysis.
- Developed a GEANT4 program to create simulated training sets of gamma spectra for individual isotopes and combinations.
- Created two neural networks to compare the effects of training a neural network on wavelet analysed gamma spectra against training a network on non-wavelet analysed gamma spectra.

Assessing the strength of biomineral strategies for concrete repairs

Thanos Karampourniotis
PhD,
University of Strathclyde

Wish list

- To create a model that predicts the mechanical behaviour of fractured concrete, repaired using the Microbially Induced Carbonate Precipitation technique.
- To complete training in the Civil and Environmental Engineering research laboratories.
- To design and conduct our own experiments
- To be able to conduct field trials before the end of the PhD.

Progress

- Created a numerical model that initially focuses on fractured granite cores, repaired using the Microbially Induced Carbonate Precipitation approach.
- Completed training in the Microbiology laboratories.
- Reading literature for the first year PhD review.

Assessing the properties and release behaviour of products arising from metallic and exotic fuel corrosion

Haris Paraskevoulakos,
PDRA,
University of Bristol

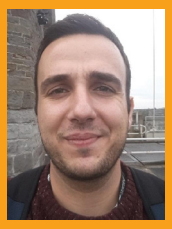
Wish list

- Investigation of uranium corrosion behaviour (rates, morphology etc) in different environments
- Investigation of corrosion products identity in samples corroding under ambient conditions for 1 plus year
- Investigation of large-scale samples produced by industry several years ago,
- using non-destructive techniques.

Progress

- Work performed in uranium corrosion in Magnox sludge has been published
- A part of our large-scale samples has been investigated using tomographic methods and the relevant data are currently under processing

An investigation of corrosion and leaching of carbide fuels in a Geological Disposal Facility (GDF) setting.



Dimitris Samaras,
PhD,
University of Bristol

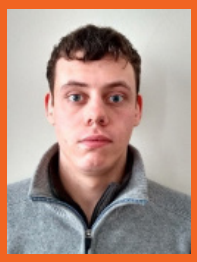
Wish list

- Carbide specimens of higher structural integrity, which will allow for cutting into smaller cubes for further analysis.
- Alternatively, carbide samples of smaller dimensions, for which analysis techniques sensitive of sample size can be implemented.

Progress

- A sample disintegrated whilst being cut, revealing its interior to be in powder form, in contrast with the solid surface of the pellet
- EBSD conducted on the second pellet displayed little to know useful information
- X-Ray Diffraction on the salvaged powder revealed peaks that do not match the ones predicted for the monocarbide (usually the most common stoichiometry); however, there seems to be a correlation between simulated peaks for sesquicarbide. A uranium oxide peak was also identified. Further analysis is to be conducted on this.

The Safe Disposal of Advanced Nuclear Fuels



Ian Robertson
PhD,
Lancaster University

Wish list

- Characterisation of the cerium europium series of mixed oxalates by Raman, SEM, XRD and TGA.
- Calcination of the mixed oxalates to mixed oxides followed by characterisation by Raman and SEM.
- Fabrication of mixed oxide pellet electrodes for electrochemical corrosion studies.

Progress

- Pure CeO2 pellet produced, sintered and fabricated into an electrode.
- CeO2 pellet surface has been characterised by Raman spectroscopy and SEM.
- Demonstrated the resistivity of the pure CeO2 electrode to a current flow using cyclic voltammetry.
- Pellets containing a mixture of CeO2 and Nd2O3 or Eu2O3 through the co-milling of powders were produced, sintered and finally characterised with Raman spectroscopy.
- Commenced the co-precipitation of a series of mixed cerium/europium oxalates to act as a precursor to a homogeneously mixed oxide powder.

Characterisation of AGR Fuel and its Behaviour During Drying

Thomas Bainbridge,
PhD,
University of Leeds

Aims & Objectives

- Micrographs of cracks of a known length and width. Particularly failed AGR fuel cladding or stress corrosion cracks.

Progress

- Code written to determine the length and average with of a crack.
- Continuing to code various methods of determining the flow through a crack.
- Drop evaporation test rig built to crack stainless steel plate samples.

Development of Micromechanical Testing Methods for Spent AGR Cladding to Examine Effects of Sensitisation and Stress Corrosion Cracking

Kuo Yuan,
PhD,
University of Bristol

Aims & Objectives

- Tests to determine the relationship between Cr depletion and grain boundary plane orientation on sensitised 304 stainless steel and potentially AGR cladding
- In-situ synchrotron tests of SCC
- Small punch tests on SCC with implementation of DIC

Progress

- Passed first year annual review
- Found and modified the code to convert EBSD data to Abaqus FEA
- Developed and built a novel testing small punch test rig for SCC
- Proposed in-situ tests for SCC at synchrotron light sources

In-situ identification of surface corrosion products on spent nuclear fuel

Victoria Frankland
PDRA
University of Surrey

Wish list

- Expand the range of potential spent nuclear fuel alteration products (including reference collection mineral specimens and synthetic samples) for characterisation by Raman and luminescence spectroscopy.
- Verification of the characterisation findings against 'real' spent nuclear fuel samples held at Central Labs.
- Begin laser-induced breakdown spectroscopy (LIBS) calibration and characterisation experiments; an elemental abundance analysis technique more appropriate for 'stand-off' nuclear applications.
- Access to or purchase of a UV/vis spectrometer to better understand the luminescence mechanism occurring in uranyl-bearing materials.

Progress

- Successful characterisation by Raman and luminescence spectroscopy of:
- Uranyl oxides: becquerelite, studtite, α-uranium trioxide, vandenbrandeite and vandendriesscheite.
- Uranyl phosphate: Sr-rich meta-autunite.
- Uranyl silicates: boltwoodite and uranophane.
- Uranyl sulfates: johannite and natrozippeite.
- Observation of luminescence signal intensity dependent on the associated metal cation.
- Successful installation and commissioning of a tandem LIBS-LA instrument connected to an existing ICP-MS.
- Publication of paper entitled "Characterisation of meta-autunite: Towards identifying potential alteration products of spent nuclear fuel". A second paper focusing on becquerelite and vandendriesscheite characterisation has been submitted.

Alteration of Spent Nuclear Fuel

Joshua Bright,
PhD,
University of Surrey

Wish list

- Access to epitaxial UO2 thin films from Transcend collaborators for corrosion experiments that can be performed alongside computer simulations.
- Access to capability for performing corrosion experiments on both AGR fuel and spent nuclear fuel.
- Access to UV/Vis, FT-IR and ion-bean equipment to allow for more detailed understanding of corrosion mechanisms.

Progress

- Simulations prepared for selection of UO2 surfaces with CASTEP.
- Some initial characterisation experiments performed on natural UO2 mineral sample, to be followed with corrosion experiments.
- Initial understanding of how differing sample matrices (i.e. finely divided powder vs bulk crystal) can lead to the creation of electronic states that do not belong to the bulk and may interfere when observing both fluorescence and Raman spectroscopy.

Building the foundations of a predictive tool for spent fuel behaviour

Jacek Wasik,
PDRA,
University of Bristol

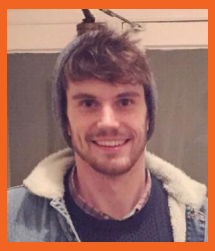
Wish list

- Access to an optical microscope with high precision stage, equipped with long working distance high magnification lenses.
- Increased access to the laboratories to perform more experiments.

Progress

- Synthesis of uranium and uranium dioxide powders
- X-ray characterization of samples
- Initial in-situ optical microscopy dissolution studies of uranium dioxide particles.

Building a predictive tool for spent fuel behaviour



Angus Siberry
PhD,
University of Bristol

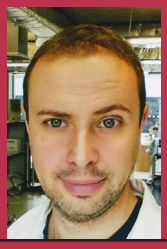
Wish list

- To have a fully functioning spent fuel alpha and beta dosimetry model for cracks, small particles and a planar surface exposed to water
- Have the model fully integrated into a computer program available for public use

Progress

- Fully functioning alpha dose rate calculator developed including crack and spherical geometry's
- Linked radiolytic generation through water
- 1D spent fuel dissolution model in COMSOL

The Surface Chemistry of Plutonium Dioxide under Conditions Relevant to Interim Storage



Domnic Laventine,
PDRA,
Lancaster University

Wish list

- Plutonium or alpha active analysis lab in the UK that is actually accessible by visiting researchers within a project time-frame. Especially for Raman, BET, SEM, XRD, XPS, XRF, AFM.

Progress

- Successfully applied for pilot-study funding for alpha-irradiation studies at Dalton Cumbria Facility (DCF)
- Prepared and transported ceria samples for alpha-irradiation at DCF, awaiting beam-time.
- Renewed security, medical, and classified worker status for work at Sellafield Ltd.

Atomistic simulation of Am incorporation into PuO_2

William Nielson
PhD,
Lancaster University

Wish list

- A many bodied potential that describes the helium - actinide interaction
- Collaboration with researchers investigating defect chemistry. We have developed an analysis package that predicts materials defect concentrations and is open to use.

Progress

- Completed manuscript reporting results of the defect chemistry of PuO_2.
- Have investigated how americium is incorporated in the PuO_2 lattice and its impact upon the defect chemistry of PuO_2, with good corroboration with experimental results.

Quantum chemical modelling of PuO_2 surface chemistry

Xiaoyu Han
PDRA,
University of Manchester

Aims & Objectives

- Understand the surface chemistry of the ThO_2. Extension to PuO_2.
- Study the ThO_2 surfaces interaction with water and the water splitting reaction pathway.
- And the full free energy of the reaction pathway will be delivered. Extension to PuO_2.
- Other small molecules reaction with surface of the ThO_2

Progress

- Work has continued on modelling water adsorption on ThO_2, which we study as a surrogate for PuO_2. We are currently preparing a manuscript entitled "Computational study of the energy landscape of water on the ThO_2(111) surface".
- Simultaneously, we have begun studying PuO_2 using the DFT+U approach; the effect of the Hubbard U factor on PuO_2 bulk has been systematically studied. The surface energy, density of states, water adsorption and dissociation are all found to be highly dependent on the choice of the U factor.
- We are also studying PuO_2 with hybrid DFT, to further inform our choice of U.

Gas Generation from the Radiolysis of Water on Uranium and Thorium Oxides

Chris Anderson,
PhD,
University of Manchester

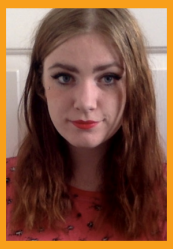
Wish list

- Extra funding to acquire a supply of radiation resistant valves and sensing equipment for the experimental manifold.
- There may be a need to acquire Uranium and extra Thoria for 2021 experiments

Progress

- Experimental manifold for radiolysis experiments has exited design phase and is now under construction
- RH/T/P sensors underwent radiation hardness testing. Effective up to 8 kGy
- Solenoid valves identified and currently being radiation hardness tested.
- Test experiments on the manifold to be ran in early 2021.

Atomistic Simulation of the ageing of PuO_2



Elanor Murray,
PhD,
University of Birmingham

Wish list

- To get started with molecular dynamic simulations of helium migration pathways using DL_POLY
- Experimental findings of the helium content in storage canisters
- To develop a possible bubble formation mechanism of helium in PuO_2

Progress

- Simulated various surfaces of PuO_2 finding the (111) surface to be the most energetically favourable
- Developed a Pu-He interatomic potential
- Simulated helium incorporation at a range of trapping sites and the build-up of helium at these sites
- Found plutonium vacancies to be favourable trap sites for helium aggregation

The Radiolysis of Water over Plutonium Oxide

Cameron Williams,
PhD,
Lancaster University

Wish list

- To conduct initial experimentation with a view to gain a deeper understanding of the water reformation mechanism
- To utilise a range of experimental techniques to examine the surface chemistry of metal oxide species
- To determine the effectiveness of a variety of simulant species compared to Plutonium Oxide

Progress

- Since starting in October 2020 I have focussed on research and literature studies
- I have examined a variety of available literature across a range of topics to gain a wider understanding of the storage of Plutonium Oxide as a whole
- I have assessed the current theories on radiolysis of water in the presence of a variety of metal oxides and am considering the effects of band gap theory on how metal oxides could act in a catalytic manner in the radiolysis of water

Synthesis, Structure and characterisation of ceramic and related wasteforms for radioactive waste immobilisation

Shikuan Sun,
PDRA
University of Sheffield

Wish list

- Access to plutonium materials chemistry laboratory for validation studies
- Installation and commissioning of U-active HIP upgrade at Univeristy of Sheffield
- Ion beam irradiation of ceramic specimens to investigate radiation damage behaviour
- High resolution synchrotron X-ray diffraction studies of high temperature phase transitions

Progress

- Synthesis and characterisation of zirconolite ceramic formulations for immobilisation of Np; Wei et al., Ceram. Int. 2021, 47, 1047-1052.
- Synthesis, characterisation and evaluation of Cr charge compensated zirconolite ceramic formulations for immobilisation of UK Pu; Blackburn et al., J. Eur. Ceram. Soc., 2020, 40, 5909-5919.
- Rapid microwave synthesis and sintering of zirconolite ceramics, Wei et al., J. Nucl. Mater., 2020, 539, 152332.
- Systematic investigation of the CaZr1-xCexTi2O7 solid solution as an analogue of Pu disposition, Blackburn et al., J. Nucl. Mater., 2020, 535, 152137.

Disposability of waste-forms for plutonium immobilisation and efficacy of surrogates

Clemence Gausse,
PDRA,
University of Sheffield

Wish list

- Finding an easier way to open HIP cans without damaging the sample in order to prepare reproducible monoliths. Currently it takes more than 2 weeks to open it…
- I'm hoping to be able to go to ANSTO in Australia in order to complete dissolution experiments on the Pu-doped samples.

Progress

- Synthesis and characterisation of a HIPed Ce-zirconolite glass ceramic (CaZr0.9Ce0.1Ti2O7: Na2Al2Si6O16) sample as well as a HIPed Ce-zirconolite ceramic (Ca0.8Ce0.2Zr0.9Ce0.1Ti1.6Fe0.4O7) sample
- Preparation of polished monoliths for dissolution experiments
- A first set of dissolution experiment has been launched beginning of March 2020 and a second set of dissolution experiment has been started beginning of November 2020, both in conditions relevant to geological disposal facility.

New materials and methods for decontamination of effluent

Anthony Nearchou,
PDRA,
University of Birmingham.

Wish list

- Mechanical stability tests on pelletised exchange materials.
- Hot isostatic pressing of ion exchanged materials to produce ceramic wasteforms and investigate leaching of the immobilised radionuclides.
- Active ion exchange testing of the developed exchange materials.
- Computer simulations and atomistic modelling of the umbite materials to better understand the ion exchange behaviour.

Progress

- Current work has focused on tin umbites (K_2 SnSi _3 O_9·H_2 O) which show promising selective uptake of Cs+ and Sr2+ cations from solution.
- The synthesis of tin umbites has been optimised, by both reducing the time and temperature of hydrothermal conditions for crystallisation.
- The material has been successfully prepared using microwave heating, vastly reducing the preparation time.
- Ion exchange experiments have been performed, showing Cs+ uptake from solution in the presence of competitors and at varying pH.
- Preliminarily work has begun in producing tin umbite pellets which are more suited for application.

Investigation of zirconolite solid solutions for immobilisation of contaminated plutonium wastes

Merve Kuman
PhD,
University of Sheffield

Wish list

- The production of zirconolite (CaZrTi2O7) as a host for plutonium immobilisation because of to its high chemical flexibility, aqueous durability and radiation tolerance.
- The investigation of the behaviour of charge compensation species and dopants on the structural and chemical stability of zirconolite.
- The investigation of the effect of production process on ceramic formation such as cold press and sintering (CPS) and hot isostatic pressing (HIP).
- The opportunity to apply the disposal of UK separated plutonium stockpile.

Progress

- The solid solutions of Fe and Al doped zirconolite structure have been synthesised via CPS.
- The phase assemblage and structural information were provided by XRD and SEM analysis, allowing me to determine the solubility limit for higher waste loading capacity to produce via HIP.
- The solid solution synthesis will be carried out with the different cation charge compensation species to learn the role of Pu and its surrogates (Ce, U, Th) on the zirconolite structure.

Awards

- Royal Society of Chemistry, Industry-Academia Collaboration Award 2020, Awarded to The DISTINCTIVE Consortium
- Institution of Chemical Engineers, Global Awards 2020, Public Engagement Award, Highly Commended Awarded to The DISTINCTIVE Consortium
- Institution of Chemical Engineers, Global Awards 2020, Team Award, Highly Commended Awarded to The DISTINCTIVE Consortium
- Stephanie Thornber, winner European Nuclear Society High Scientific Council PhD Award 2020 for thesis 'The development of high fraction zirconolite glass-ceramics for the immobilisation of actinides in plutonium residues for long-term geological disposal'
- Antonia Yorkshire, winner 2020 Adam Neville PhD Prize for thesis 'Understanding actinide sorption and binding to cement materials for radioactive waste management'

Save the Date

We are planning to hold the 2nd Annual Meeting of the TRANSCEND Consortium in Harrogate during summer 2021.

Updates will be posted on:
our website - transcendconsortium.org and
on Twitter - @Transcend_epsrc.

Please contact Dr Lois S Tovey (l.tovey@leeds.ac.uk) if you wish to be added to the mailing list for updates/invitations.

Publications

The following are some recent peer-reviewed papers and articles published since the programme started in October 2018.

Synthesis and characterisation of Ca1-xCexZrTi2-2xCr2xO7: Analogue zirconolite wasteform for the immobilisation of stockpiled UK plutonium
Lewis R. Blackburn, Shi-Kuan Sun, Sebastian M. Lawson, Laura J. Gardner, Hao Ding, Claire L. Corkhill, Ewan R. Maddrell, Martin C. Stennett, Neil C. Hyatt
Journal of the European Ceramic Society Volume 40, Issue 15, December 2020, Pages 5909-5919

A systematic investigation of the phase assemblage and microstructure of the zirconolite CaZr1-xCexTi2O7 system
Lewis R. Blackburn, Shikuan Sun, Laura J. Gardner, Ewan R. Maddrell, Martin C. Stennett, Neil C. Hyatt
Journal of Nuclear Materials Volume 535, July 2020

Computational Study of the Bulk and Surface Properties of Minor Actinide Dioxides MAnO2 (MAn = Np, Am, and Cm); Water Adsorption on Stoichiometric and Reduced {111}, {110}, and {100} Surfaces
Jia-Li Chen and Nikolas Kaltsoyannis
J. Phys. Chem. C 2019, 123, 25, 15540–15550

Reactive spark plasma sintering of Cs-exchanged chabazite: characterisation and durability assessment for Fukushima Daiichi NPP clean-up
Liam. C. Harnett, Laura. J. Gardner, Shi-Kuan Sun, Colleen Mann & Neil. C. Hyatt
DOI: 10.1080/00223131.2019.1602484

Safe management of the UK separated plutonium inventory: a challenge of materials degradation
Neil C. Hyatt
npj Materials Degradation 4, 28 (2020)

Preliminary investigation of chlorine speciation in zirconolite glass-ceramics for plutonium residues by analysis of Cl K-edge XANES
Amber R. Mason, Stephanie M. Thornber, Martin C. Stennett, Laura J. Gardner
MRS Advances Volume 5, Issue 1-2 (Scientific Basis for Nuclear Waste Management XLIII)2020 , pp. 37-43

Density ratio effects on the topology of coherent turbulent structures in two-way coupled particle-laden channel flows
L.F. Mortimer and M. Fairweather
Physics of Fluids 32, 103302 (2020)

Near-wall dynamics of inertial particles in dilute turbulent channel flows
L. F. Mortimer, D. O. Njobuenwu and M. Fairweather
Physics of Fluids 31, 063302 (2019)

Agglomeration dynamics in liquid–solid particle-laden turbulent channel flows using an energy-based deterministic approach
L. F. Mortimer, D. O. Njobuenwu and M. Fairweather
Physics of Fluids 32, 043301 (2020)

Enhanced electrokinetic remediation of nuclear fission products in organic-rich soils
Jamie M. Purkis, Andrew Tucknott, Ian W. Croudace, Phil E. Warwick, Andrew B. Cundy,
Applied Geochemistry - in press

Simulation of Fully Resolved Particle-Particle Interactions in Turbulence with Behavioural Modification
L.F. Mortimer, M. Fairweather and Njobuenwu
10th International Conference on Multiphase Flow – ICMF 2019, Rio de Janeiro, Brazil, 19th-24th May 2019, Paper OC.389, 2019.

Publications

A Feasibility Investigation of Laboratory Based X-ray Absorption Spectroscopy in Support of Nuclear Waste Management
L.M. Mottram, M.C. Dixon Wilkins, L.R. Blackburn, T. Oulton, M.C. Stennett, S.K. Sun, C.L. Corkhill and N.C. Hyatt
MRS Advances Volume 5, Issue 1-2 (Scientific Basis for Nuclear Waste Management XLIII)2020 pp.27-35

Managing our plutonium legacy (2019)
N.C. Hyatt
Science in Parliament, Vol 5 Issue 3

Observation of dose-rate dependence in a Fricke dosimeter irradiated at low dose rates with monoenergetic X-rays
Mel O'Leary, Daria Boscolo, Nicole Breslin, Jeremy M. C. Brown, Igor P. Dolbnya, Chris Emerson, Catarina Figueira, Oliver J. L. Fox, David Robert Grimes, Vladimir Ivosev, Annette K. Kleppe, Aaron McCulloch, Ian Pape, Chris Polin, Nathan Wardlow & Fred J. Currell
Scientific Reports volume 8, Article number: 4735 (2018)

The role of crystal orientation in the dissolution of UO2 thin films
S.Rennie, E.Lawrence Bright, J.E.Sutcliffe, J.E.Darnbrough, R.Burrows, J.Rawle, C.Nicklin, G.H.Lander, R.Springell
Corrosion Science Volume 145, December 2018, Pages 162-169

Solubility, speciation and local environment of chlorine in zirconolite glass–ceramics for the immobilisation of plutonium residues
Stephanie M. Thornber, Lucy M. Mottram, Amber R. Mason, Paul Thompson, Martin C. Stennett and Neil C. Hyatt
RSC Advances Issue 54, 2020

Rapid synthesis of zirconolite ceramic wasteform by microwave sintering for disposition of plutonium
Zi-JunWei, Lewis R. Blackburn, Laura J. Gardner, Sheng-Heng Tan, Shi-Kuan Sun, Wei-Ming Guo, Neil C. Hyatt, Hua-TayLin,
Journal of Nuclear Materials Volume 539, October 2020, 152332

Raman analysis of meta-autunite
V. Frankland, R. Bance-Souhali and D. Read
Environmental Radiochemical Analysis VI: 79-88, 2019. RSC Special. Pub. 354. IBSN:978-1-78801-735-0.

Characterisation of meta autunite: Towards identifying potential alteration products of spent nuclear fuel
V. Frankland, A. Milodowski and D. Read.
Appl. Geochem. 123: 104792, 2020. DOI: 10.1016/j.apgeochem.2020.104792

Influence of Transition Metal Charge Compensation Species on Phase Assemblage in Zirconolite Ceramics for Pu Immobilisation
L.R. Blackburn, S.K. Sun, L.J. Gardner, E.R. Maddrell, M.C. Stennett and N.C. Hyatt
MRS Advances , Volume 5 , Issue 1-2: Scientific Basis for Nuclear Waste Management XLIII , 2020 , pp. 93 - 101

Synthesis of zirconolite-2M ceramics for immobilisation of neptunium
Zi-Jun Wei, Weichao Bao, Shi-Kuan Sun, Lewis R.Blackburn, Sheng-HengTan, Laura J.Gardner, Wei-MingGuo, FangfangXu, Neil C.Hyatt, Hua-TayLin
Ceramics International Volume 47, Issue 1, 1 January 2021, Pages 1047-1052

Publications

Application of plasma mass spectrometry for half-life measurement of medium and long-livedradionuclides.
E. Braysher, B. Russell and D. Read. J. Phys. Conf. Ser. 1643 012207 (2020).

The use of Raman and TRLF spectroscopy for differentiating early stage alteration products of Spent Nuclear Fuel.
V. Frankland, A. Milodowski, J. Bright and D. Read.
Accepted by Appl. Geochem.

Crystal and Electronic Structures of A2NaIO6 Periodate Double Perovskites (A = Sr, Ca, Ba): Candidate Wasteforms for I-129 Immobilization
Sarah E. O'Sullivan, Eduardo Montoya, Shi-Kuan Sun*, Jonathan George, Cameron Kirk, Malin C. Dixon Wilkins, Philippe F. Weck, Eunja Kim*, Kevin S. Knight, and Neil C. Hyatt
Inorg. Chem. 2020, 59, 24, 18407–18419

The formation of stoichiometric uranium brannerite (UTi2O6) glass-ceramic composites from the component oxides in a one-pot synthesis
Malin C.Dixon Wilkins, Martin C.Stennett, EwanMaddrell, Neil C.Hyatt
Journal of Nuclear Materials, Vol 542, 2020, 152516

Molten salt synthesis of Ce doped zirconolite for the immobilisation of pyroprocessing wastes and separated plutonium
Amber R.Mason, Florent Y.Tocino, Martin C.Stennett, Neil C.Hyatt
Ceramics International Vol. 46, Issue 18, Part A, 15 December 2020, Pages 29080-29089
Volume 46, Issue 18, Part A, 15 December 2020, Pages 29080-29089

The Effect of Temperature on the Stability and Cerium Oxidation State of CeTi2O6 in Inert and Oxidizing Atmospheres
Malin C. Dixon Wilkins, Ewan R. Maddrell, Martin C. Stennett, and Neil C. Hyatt
Inorg. Chem. 2020, 59, 23, 17364–17373

Structure of NaFeSiO4, NaFeSi2O6, and NaFeSi3O8 glasses and glass-ceramics
Mostafa Ahmadzadeh; Alex Scrimshire; Lucy Mottram; Martin C. Stennett; Neil C. Hyatt; Paul A. Bingham; John S. McCloy
American Mineralogist (2020) 105 (9): 1375–1384.

Characterisation and disposability assessment of multi-waste stream in-container vitrified products for higher activity radioactive waste
Sam A.Walling, Marcus N.Kauffmann, Laura J.Gardner, Daniel J.Bailey, Martin C.Stennett, Claire L.Corkhill, Neil C.Hyatt
Journal of Hazardous Materials, Volume 401, 5 January 2021, 123764