updates from
DISTINCTIVE
EDITION 3 | December 2016

DISTINCTIVE - A Busy Year

By Prof. Michael Fairweather, Consortium PI, University of Leeds

It's been a busy period for the DISTINCTIVE consortium.

Apart from continuing our world-class research we have:

- Attended the Waste Management Symposium in Phoenix in March
- Held our 2nd Annual Meeting in Bristol in April
- Had the Public Engagement and Media Summer School in June
- Held 2 days of Theme Meetings in Cumbria in November.

This edition of the newsletter includes reports on three of the activities noted above: attendance at the Waste Management Symposium; a report on our 2nd Annual Meeting; and details of our Public Engagaemnt and Media Summer School. We also include reports on the status of our Active Research Fund, as well as a report on a visit to the Hanford Waste Treatment Plant in Washington State by two researchers on the project.

The 3rd Annual Meeting is also rapidly approaching. This year it will be held in York in April. The event will follow a similar format as previous years, with presentations across our four technical themes from PhD students and PDRAs, as well as keynote speakers.

I encourage you to register early for this event as the limited number of spaces will fill up quickly!

A focus of this years Annual Meeting will be recruitment and careers in the nuclear industry. We have therefore included a number of career profiles from colleagues in a number of companies in this edition of the newsletter. We also asked our researchers to write about their career aspirations as well as progress with their projects. You can find these summaries inside.

We look forward to seeing you in April!

(M.Fairweather@leeds.ac.uk)

CONTENTS

Research Councils UK Energy For a Low Carbon Future

Active Research Fund

At the time of submitting a proposal to the EPSRC, a number of PDRA projects indicated a potential need for active research facilities; however, a detailed understanding of facility needs and the duration of work was unable to be defined. As a result, an Active Research Fund (ARF) was requested.

In total, £288k was awarded to the consortium as part of the DISTINCTIVE grant (EP/L014041/1) to facilitate active research, including international secondments and small equipment purchases.

An ARF Call is announced every six months, and our PDRAs are asked to submit a proposal outlining how the funding will be used and how the sub-project will support the strategic aims of the consortium.

All proposals are reviewed by the programme's Management Board. The review is chaired by Prof. Simon Pimblott (University of Manchester) who is the cross-cutting champion in this area. He has the responsibility to promote the use of active facilities and to ensure that the consortium receives excellent advice and support , especially relating to technical needs and duration of work.

We have held four calls and 13 sub-projects have been supported. Project summaries from rounds 1 & 2 were provided in the last newsletter. Here the successful candidates summarise the proposed work for projects funded from Rounds 3 & 4.

Round 3

Building and Commissioning a Vacuum Sampling System for PuO_2 Glovebox Experiments

Dr Luke Jones - University of Manchester

The aim of this project is to build and commission a vacuum sampling system to be deployed and utilised with a gas chromatograph in NNL-central Lab. This system will allow for longer term experiments with in-situ analysis which will reduce cross-contamination and impurities from outside influences on samples.

A Hot Isotopic Press Upgrade for Processing of Radioactive Materials

Dr. Shi Kuan Sun– University of Sheffield

The project aims to develop ceramic and glass-ceramic materials for actinide wastes. The DISTINCTIVE active equipment fund has allowed us to upgrade our research scale Hot Isostatic Press (HIP), to be able to routinely process significant inventories of radioactive material. Within DISTINCTIVE, we will utilise the capability to achieve proof of concept manufacture of uranium containing ceramics by hot isostatic pressing, providing sufficient volume of material to investigate the long term aqueous alteration mechanisms, which is essential evidence to establish waste package disposability. In so doing, we have created a unique national facility for research of this type, placing the UK at the forefront of the development of HIP technology for waste immobilisation applications.

Hard X-ray Absorption Spectroscopy Studies at the Photon Factory - Japan

Dr. Shi Kuan Sun – University of Sheffield

This project aims to develop ceramic and glass-ceramic materials for actinide wastes. The DISTINCTIVE active equipment fund has allowed us to access state of the art X-ray Absorption Spectroscopy techniques at the Photon Factory (Japan) to probe the redox state of plutonium surrogates in, and radiation damage behaviour of, our glass ceramic formulations for immobilisation of UK plutonium residues. X-ray absorption spectroscopy is an essential tool in this regard, providing information on element oxidation state (according to the chemical shift of the X-ray absorption edge) and the local structure of the radiation amorphised material.

Round 4

A Lab-scale Fixed Bed Reactor to Investigate Gas Phase Kinetics for Long Term PuO_2 Storage

Dr Luke Jones and Thomas Donoclift – University of Manchester

The aim of this project is to build and commission a bench scale fixed bed reactor which will allow investigation of catalytic and thermal reactions between the gas phase and a bed of oxide powder such as PuO_2 and appropriate surrogates. This project will help to obtain a better kinetic understanding of thermal and catalytic mechanisms occurring inside storage canisters. The ultimate objective of the project is to install this equipment inside a glovebox at the NNL's Central Lab to carry out experiments to simulate the chemistry inside PuO_2 storage canisters.

Study of Physico-Chemical Interactions Between PuO_2 and H_2O

Dr. Dominic Laventine – University of Lancaster

More than 100 tonnes of Pu are stored in the UK, typically as plutonium dioxide (PuO_2) powder contained within nested stainless steel cans. Under some conditions, these cans pressurise due to production of gas within the can. This makes the cans difficult to store and handle and must be avoided in practise.

A number of chemical and radiological processes that involve trapped water in the cans have been suggested as the cause of this gas production. We aim to precisley measure absorption / release of gases including water vapour from PuO_2 surfaces using highly accurate piezoelectric crystal balances. This will allow prediction of PuO_2 behaviour during long term storage, allowing it to be safely stored.

Developing ERT Equipment for the Detection of Colloidal Silica Grout

Dr Matteo Pedrotti– University of Strathclyde

The proposed project aims to facilitate detection of colloidal silica-based grouts during creation of hydraulic ground barriers, with a particular emphasis on applications within the challenging environment of the Sellafield site. Potential grout applications at Sellafield include: the injection of horizontal and vertical barriers to form a second skin for unlined waste disposal trenches; and saturation injection for complete ground sealing beneath high hazard facilities, as a risk mitigation strategy during waste retrieval.

Sellafield site, as with most of the nuclear sites, is a highly contaminated and congested area. Many parts of the site are not directly accessible either because other buildings prevent access, or because of site contamination and radiological hazard.

Consequently, the strategic aim of the proposed project is to acquire, develop and test a non-invasive imaging system that can reliably detect the location (and shape) of a grouted soil volume within a radiological environment, whilst also requiring limited site access.

In many applications, the boreholes used for grout injection will be a long distance from some sections of the final barrier. This is particularly true for horizontal containment, in which injection and extraction boreholes may be 10s of meters apart. To ensure reliable barrier formation over such distances, it will be particularly important to image the real-time grout injection so that both the grout properties and the hydraulic engineering design strategy can be adjusted in situ to account for heterogeneous flow conditions. Further, since colloidal silica injection is intended to be a durable intervention technique even under long-term exposure to radiation, the possibility of being able to routinely monitoring barrier condition, years after the injection, is the sine qua non for its future asset management.

Investigation of Radiation Damage by Mossbauer Nuclear Spectroscopy

Dr. Shi Kuan Sun – University of Sheffield

This project aims to exploit Mossbauer spectroscopy to understand radiation damage in ceramic materials for actinide wastes. The DISTINCTIVE active equipment fund has allowed us to procure two radioactive sealed sources, and ancillary items, for our existing Mossbauer spectrometer to allow element specific investigation of the average atomic scale structure of ion bean amorphised ceramic materials. Within DISTINCTIVE, we will utilise this enhanced capability to build on our proof of concept studies to understand the mechanisms of the crystalline to amorphous phase transition in ceramic wasteforms, which will contribute to the disposal system safety case. In doing so, we have created a unique national facility for research of this type, placing the UK at the forefront of the application of Mossbauer spectroscopy to waste immobilisation applications.

In Situ High Resolution Neutron Diffraction Studies of Glass-Ceramic Crystallisation

Dr. Shi Kuan Sun– University of Sheffield

The aim of this project is to characterize and understand the sequence of crystallization reactions which occur during the processing of zirconolite glass-ceramics, by kinetic neutron diffraction. Fundamentally, the primary mechanism of zirconolite formation in this glass-ceramic system is unknown. The bounding hypothetical models involve i) a template mechanism with dissolution of some batch components and diffusion to reaction sites, or ii) dissolution of all batch components and precipitation of solubility limited target phases. This experiment will resolve our hypothesis using neutron diffraction to characterize the evolving phase assemblage during material processing, which is the only method of interrogating samples of cm^3 volume. Knowledge of the fundamental mechanism of zirconolite formation in this glass-ceramic system is important for development of a safety case to support a full scale process facility.

The DISTINCTIVE University Consortium gratefully acknowledges funding from the EPSRC as part of the Research Councils UK Energy programme.

The Energy Programme is a Research Councils UK cross council initiative led by EPSRC and contributed to by ESRC, NERC, BBSRC and STFC

EPSRC
Engineering and Physical Sciences Research Council

Dr Jones' PDRA project is titled "Understanding the Interfacial interactions of Plutonium Dioxide with Water". His lead supervisor is Dr Simon Pimblott (Simon.Pimblott@manchester.ac.uk).

Dr Shi Kuan Sun's PDRA project is titled "Ceramic Materials for Actinide Disposition". His lead supervisor is Professor Neil Hyatt (n.c.hyatt@sheffield.ac.uk).

Dr Laventine's PDRA project is titled "Understanding the Interfacial Interactions of Plutonium Dioxide with Water". His lead supervisor is Professor Colin Boxall (c.boxall@lancaster.ac.uk).

Dr. Pedrotti's PDRA project is titled " In-situ Ground Contaminant Containment (Physical Barrier)". His lead supervisor is Dr. Grainne El Mountassir (grainne.elmountassir@strath.ac.uk).

Reporting back from Phoenix

DISTINCTIVE had a notable presence at the Waste Management Symposium held in Phoenix, Arizona between the 6th and 10th March 2016

DISTINCTIVE organised a dedicated technical session at the conference. The session consisted of eight talks providing an overview of the programme objectives, an industrial perspective on why engagement with the programme is important, and examples of our research with representatives presenting from three of the four technical themes.

Prof. Michael Fairweather, University of Leeds, opens the dedicated DISTINCTIVE session

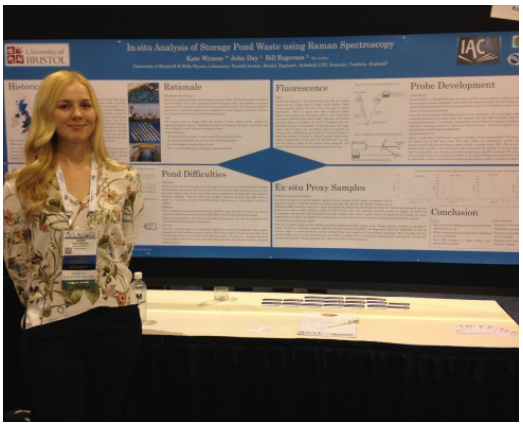
Overall, we were thrilled with the impact that it had. The average number of attendees was around 30, most of whom were new faces to the consortium. It was apparent that delegates were popping in and out to attend talks that were particularly interesting to them, and consequently we estimate that the total number of participants was between 50 and 60.

There was a genuine enthusiasm for the programme, and not just because attendees were provided with a social networking event after the session! Attendees included representatives from the US DOE, the IAEA, the US Nuclear Waste Technical Review Board, the Australian Nuclear Science and Technology Organisation, and various universities and national labs from across the US.

In addition 7 other papers were presented by DISTINCTIVE researchers which were all well received.

There have already been valuable outputs, from requests for contact details for specific research projects, to new members joining the consortium's International Advisory Group. The challenges addressed by DISTINCTIVE are experienced overseas and it is important that the consortium continues to disseminate its advances both within the UK and internationally. This will ensure that there isn't any overlap, that best practises are shared, that we learn from experience and it will also help the programme identify where there are opportunities for collaboration. We have already received invitations for the consortium to participate at future events within the US and EU. We will explore these prospects and keep you updated.

The poster sessions at the event also proved to be a success. They attracted a high volume of delegates - our presenters were kept very busy with questions! We would encourage our researchers to consider this option for next year's event, especially if your project is relevant to the Japanese industry as this will be the featured nation in 2017.



Kate Wyness, PhD researcher at the University of Bristol, with her poster titled 'In situ Analysis of Storage Pond Waste using Raman Spectroscopy'

Don't forget to consider applying for the Roy G. Found Post scholarship. The award includes a bursary and full participation at the event including travel and accommodation. Congratulations again to Stephanie Thornber, Luke Boast (Sheffield) and Dimitri Pletser (Imperial) who received the award this year. Other award winners were Luke Boast (UK Featured Nation) and Andre Botha (University of Leeds - NNL Bursary).

Thank you also to Prof. Barry Lennox (University of Manchester), Keith Miller (NNL) and members of our International Advisory Group for helping to coordinate our presence at the event, to Dr. Mike Angus (NNL) and Prof. Ian Pegg (Catholic University of America) for chairing the DISTINCTIVE session and to Longenecker and Associates for sponsoring the DISTINCTIVE social.

DISTINCTIVE Public Engagaement and Media Summer School

Dr Claire Corkhill, University of Sheffield

With decommissioning, nuclear waste treatment and the UK nuclear legacy often featured in the news, and questioned by policy makers, ministers and the public alike, researchers in our field are often put in the spotlight to discuss our research. It is more important than ever that the issues, and the important research questions that we investigate, are communicated effectively to a wide range of audiences.

Tom Sheldon of the Science Media Centre on how scientists can help the press to 'get it right'

As part the project's impact activities, 30 PhD students and postdocs from DISTINCTIVE attended a 3-day summer school on public engagement, media and science writing at Halifax Hall in Sheffield this June. A series of activities, from designing public engagement events, to taking part in a press conference, aimed to give our researchers the confidence to communicate their research now, and in their future academic or nuclear industry careers.

Neil Hyatt taking a stroll around Chernobyl with Mike Wood

Inspired by Dr. Mike Wood's (Salford University) "Virtual Chernobyl", a virtual reality experience of the Chernobyl Exclusion Zone, the participants competed in a Dragon's Den competition to win funding for their own public engagement activity. Four fantastic ideas were developed, with the "DISTINCTIVE Playground" the outright winner – well done! We look forward to developing this idea with the students for public engagement events soon.

Announcing "New plutonium immobilisation technology" at mock press conference

A fantastic day with news broadcasters and the Science Media Centre had the participants understanding what the media are looking for in a good news story, and gaining confidence in handling press enquiries and interviews with journalists. This culminated in a press conference exercise where, in small teams, the participants read a statement about their research and fielded questions from a sometimes rather hostile "media", a role taken on by the rest of the participants!

To give his experiences of the media, and his thoughts on the important research of DISTINCTIVE, we welcomed Tim Yeo, New Nuclear Watch Uk (former MP and Chair of the Energy and Climate Change Committee) as our after dinner speaker.

His talk was entitled "Climate change science is compelling and the drive for a low carbon economy is overwhelming – nuclear is poised to change the game."

After dinner speaker, Tim Yeo

Creative science writing juices were stimulated by speakers from the Nuclear Hitchhiker (Dan Cooper), Mary Cruse (free-lance science writer & Diamond Light Source) and Vikki Cantrill (free-lance science writer). The participants spent some time writing about their research for their intended audience. From space batteries to how Brexit might influence geological disposal research, some excellent pieces were initiated, which we hope to feature on the Nuclear Hitchhiker, and wider, in the coming months.

Importantly, in addition to exploring new skills, after the summer school the participants felt more confident about engaging with the public and the media and writing about their research for the lay audience. They were sent away with one final instruction: go forth and share your research message!

Sheffield and Birmingham students working on their ideas for "a day-in-the-life-of" documentary about nuclear research

Visit to Hanford Waste Treatment Plant

By Michael Johnson - School of Chemical & Process Engineering, University of Leeds

Prior to this year's Waste Management conference in Phoenix, Arizona, my research supervisor, Dr Timothy Hunter, and I were invited to attend the Hanford site at Richland in the tri-cities area of Washington State. Hanford once hosted nine reactors along the Columbia River, including the B-reactor, the first industrial scale plutonium production reactor. Now the site houses two thirds of the high level waste in the United States, stored in 177 vast underground storage tanks across a number of tank farms. The priority at Hanford has now turned to the management of this substantial legacy of secondary reprocessing waste, underpinned by the research and development at the nearby Pacific Northwest National Laboratory and validated by further trials at the impressive Full Scale Vessel Testing Facility.

Aerial photograph of the Hanford Waste Treatment Plant & Vitification Facility

Our tour began by meeting our guides for the day, Jason Chudy of the US Department of Energy and Elaine Diaz, chief engineer of the Department's Office for River Protection. An equivalent tour of the various legacy buildings at Sellafield could be undertaken by foot in a solitary afternoon; conversely, Hanford spans a vast 1500 km^2, an area roughly double that of New York City and around 250 times the area of our own centralised decommissioning facility, which stands at around 6 km^2, and hence our day trip felt like a mere introduction to the many engineering challenges encountered at the site. We drove to meet Brad Eccleston for a demonstration of the pulsed jet mixing tanks at the Full Scale Vessel Testing Facility. The Waste Treatment and Immobilisation Plant, where the low and high active vitrification lines are under development, will require 38 pulsed-jet mixing tanks, 8 of which will be tasked to homogeneously mobilise waste with more than 5 % w/w solids content prior to vitrification. Brad is involved in a considerable task to demonstrate that these tanks, each of at least 5 m diameter, can (a) mitigate actinide consolidation at the base of the tank, (b) ensure steady ventilation of hydrogen from the tank and (c) prevent damage to the tank from pressurised air, all while operating in a sealed 'black box' Pretreatment Facility with no access for radiation workers.

Our day concluded with a visit to the 'C-farm' and the low level vitrification plant facility, with a briefing from Chris Kemp on his decades of experience managing the underground tanks. Chris updated us on the progress evacuating waste from the tanks which have leached radionuclides due to a shipment of non-compliant stainless steel. The C-farm hosts a couple of renowned problem tanks associated with episodic releases of hydrogen produced by the radiolysis of water from the beta-decay of water soluble caesium and strontium. The vitrification facility will be, by some margin, the largest glass forming waste facility in the world with state-of-the-art melter designs, which we were able to see in detail, as the plant is currently being commissioned.

Collectively, the Hanford tour provided a number of lessons for decommissioning Magnox-era legacy buildings and Highly-Active Storage Tanks at Sellafield, and so we look forward to an ongoing collaboration to help advance the clean-up of both Hanford and Sellafield.

2nd Annual Meeting - Bristol 2016

The Consortium held its 2nd Annual Meeting in Bristol on Tuesday 19th and Wednesday 20th April 2016.

The academics and researchers involved in the programme were joined by representatives from industry and the wider nuclear sector to share the research advances made in the area of nuclear waste management and decommissioning since the programme started in February 2014.

Keynote presentations were given by world renowned experts from the USA: Professor Rodney Ewing (Stanford University), Dr John Vienna (Pacific Northwest National Laboratory) and Professor John McCloy (Washington State University).

DISTINCTIVE researchers gave oral presentations on their research in our four technical themes: AGR, Magnox and Exotic Spent Fuels; PuO_2 and Fuel Residues; Silo Ponds and Legacy Waste; and Structural Integrity. The poster sessions held over the coffee and lunch breaks generated a lot of interest and provided an opportunity for our researchers to discuss their work with the wider nuclear community.

Everyone enjoyed catching up at the conference dinner held on the SS Great Britain .

The NDA sponsored two awards; one for the best oral presentation and one for the best poster presentation. Industry delegates voted for the winners - congratulations to Claudia Gasparini (Imperial College) for best oral presentation and Sophie Rennie (University of Bristol) for best poster.

The consortium would like to take this opportunity to thank Professor Tom Scott and colleagues at the University of Bristol who put in significant time and effort to ensure that the annual meeting was a success.

An Invitation...

You are invited to join us at the 3rd DISTINCTIVE Annual Meeting

The Annual Meeting forms the core of our networking and knowledge transfer activities. It brings together our researchers, our academic and industrial supervisors, our management boards and other stakeholders to share advances made in the area of nuclear waste management and decommissioning over the last 12 months.

Next year's event will be held at the National Railway Museum in York, UK on Tuesday 5th and Wednesday 6th April.

Registration will be open in January and is free for all partners and associates. Spaces are limited and you are advised to register early to avoid disappointment.

Agenda

We will have presentations from keynote speakers highlighting the challenges facing the nuclear sector and the usefulness of programmes such as DISTINCTIVE in addressing such challenges.

We will also have presentations on employability from 4 ex-DIAMOND alumni working in different sectors of the industry

Oral Presentations will be given by our DISTINCTIVE researchers across the four technical sessions that align with the structure of the programme:

- AGR, Magnox and Exotic Spent Fuels
- PuO_2 and Fuel Residues
- Silo Ponds and Legacy Wastes
- Structural Integrity

In addition, each researcher has been asked to contribute a poster to this event. As such, it's a great opportunity to get a comprehensive overview of the work being done and the current status of the programme.

Sponsorship

Once again, the NDA have kindly offered to sponsor two PhD student awards; one for the best oral presentation and one for the best poster presentation. The awards will be presented by Dr. Rick Short, Research Manager, NDA, towards the end of the conference.

Other sponsorship opportunities, including exhibition spaces, are currently available. Please contact Lois Tovey (l.toveyleeds.ac.uk) for more information.

Additional

Further information about the event, including links to the venue, will be found on our website.

Joining instructions will be sent to all registered delegates one month before the event.

Please note: you must register online to attend.

Rick Short, NDA, presenting the PhD awards at last year's event

Last year's event attracted 120 delegates from academia and nuclear industrial stakeholders or relevant organisations

Nuclear Decommissioning Authority

Careers in the Nuclear Industry

The Nuclear Industry provides a variety of career opportunities/ pathways ... as shown from the career profiles below.

Dr Carlos de La Fontaine

TÜV SÜD Nuclear Technologies

Who am I?

I undertook a PhD at the University of Manchester at the Centre for Radiochemistry Research (CRR). The project was funded by the NDA, through the predesscr of the DISTINCTIVE consortium, called DIAMOND at the time.

My PhD studies

The aim of my PhD project was to study the hydrolysis process and therefore isolate actinide cluster species which are the intermediate compounds during the formation of insoluble oxides and hydroxides. To do so, I synthesised novel actinide oxide compounds by carefully controlling the hydrolysis of the system. This was performed by different means, on the one hand I prepared anhydrous organometallic compounds (actinide alkoxides) to which a marginal amount of water was added. On the other hand, I used multidentate ligands to cap "bare" actinides cations (Th, U, Pu, Np) in an attempt to control hydrolysis grow clusters in aqueous media.

The consortium also gave me the opportunity to work with Prof. Neil Hyatt on a side project at the Immobilisation Science Laboratory in Sheffield. This was a great opportunity for me as I was able to learn about solid state chemistry procedures and techniques and therefore work using a different mindset.

My current job

After completing my PhD I decided to work for a consultancy company because I was eager to broaden my knowledge of the industry as a whole and work for several Site Licensed Companies in a relatively short amount of time. This choice really paid off for me, in approximately 4-5 years I was also able to work in a broad range of projects, such as:

• Process engineering – supported the development of a new technology used for the mobilisation of sludge at the Sellafield site

• Production of integrated radioactive waste management strategies for difficult waste streams in several sites across the NDA estate

• Support to the NDA on spent fuel management (preparation of R&D roadmaps)

• Safety case of the French geological disposal facility

Dr Jennifer Rochford

Sellafield Ltd

Who am I?

I completed a PhD at the University of Manchester in the Centre for Radiochemistry Research (CRR), my specialism being the chemistry of the actinides. The project was funded by the NDA, with input from the National Nuclear Laboratory (NNL).

My PhD studies

The aim of my PhD project was to study the aqueous speciation of actinides with organic molecules relevant to the nuclear fuel cycle, specifically looking at legacy wastes but with implications throughout the fuel cycle, from mining to disposal. Throughout my PhD I worked in inert atmosphere gloveboxes to undertake experiments,

Our Website

The DISTINCTIVE University Consortium website was launched in August 2014

The website acts as a respository and showcase for key information and outcomes of the Consortium.

You can use the website to:

- Learn more about the framework and objectives of the programme.
- Find up-to-date research project descriptions and details of publications.
- Be notified of upcoming events and how to participate.
- To read latest annoucements including calls for the Active Research Fund (PDRAs only).
- Download materials from past events .
- To contact members of the consortium.

www.distinctiveconsortium.org

manipulating the oxidation states of the actinides and therefore the underpinning chemistry to provide an understanding of the chemistry behind the hydrolysis of actinides. Utilising a range of ligands (from monodentate to multi-dentate) and altering conditions such as concentrations and pH I was able to show the effect that the presence of organic molecules has on radionuclides in aqueous solutions. This has very wide implications from mobility in the environment to solubility in storage under fault conditions where water has penetrated the waste form.

I was also fortunate enough to have the opportunity to work at the Institute of TransUranics (ITU) in Karlsruhe, Germany. This allowed me to handle, experiment with and analyse plutonium compounds on a much larger scale than possible at Universities. The labs at ITU had a different set up and therefore safety regulations to those in Manchester providing me with an experience of working with greater amounts of material in a facility more closely resembling process plant than a research institute.

My current job

After completing my PhD I joined Sellafield Ltd. as part of the Facility Characterisation department. My job involves a wide range of work from; the characterisation of waste materials for sentencing and routing to disposal facilities, to developing and trialling novel techniques for sampling and analysing materials and facilities and working with sub contractors. I especially like my job as it is not focused around a single building or process and looks more holistically at the Sellafield Site and the future of the UK nuclear industry and waste management. This means I am always working with new people and developing new skills.

Dr Tamara Griffiths

NNL

Who am I?

My name is Tamara Griffiths and my interest in the nuclear industry began whilst completing my Master of Chemistry project, which I completed within the Centre for Radiochemistry Research (CRR) at the University of Manchester. After I finished my undergraduate degree, I decided to continue my studies at the University of Manchester and undertook at PhD within the CRR (from 2008 to 2012), which was funded by the Nuclear Decommissioning Authority (NDA).

My PhD Studies

My PhD was focussed on the investigation of aqueous ternary complexes relevant to Sellafield waste ponds and reprocessing techniques. The complexes I studied were metal mixed ligand complexes e.g. Lu-EDTA-carbonate and Th-DTPA-lactate. As part of my PhD, I studied these ternary complexes using a variety of techniques such as Nuclear Magnetic Resonance (NMR), luminescence and Ultra-Violet/ Visible (UV/Vis) spectroscopies, as well as potentiometry. In order to study these complexes using UV-vis and luminescence spectroscopies with exotic isotopes (243Am and 248Cm), I was given fantastic opportunities during my PhD to be seconded to Idaho National Laboratory (USA) and the National Nuclear Laboratory (UK).

My current job

After completing my PhD, I undertook an 18 month post-doctoral research associate position at the University of Manchester, where I studied 237Np redox behaviour in the PUREX process. During this time, I was seconded to the KIT-INE (Germany) to study NMR of Pu-containing systems and also seconded to the Idaho National Laboratory (USA) to investigate gamma radiolysis of Np-containing systems.

In November 2013, I began working as a research associate within the Radiochemistry team for the National Nuclear Laboratory based at Sellafied. This has given me the opportunity to work alongside world-leading experts in the field and continue to develop my knowledge and experimentally study the chemistry of the actinide ions. Working at NNL has allowed me to:

• Work on £multi-million research projects (ASGARD, ESA, SACCESS).

• Present my work to an international audience.

• Collaborate with the CEA (seconded to CEA Marcoule, France).

• Act as an industrial PhD supervisor (University of Oxford).

Career Aspirations

For this edition of the newsletter, we asked our researchers to write about their career aspirations as well as progress with their project.

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@leed.ac.uk) in the first instance.

These aspirations, as well as brief summaries of project progress made-to-date, can be found on the following pages.

Development of Characterisation Techniques for ILW Sludges

ANDRE BOTHA
PhD Student, University of Leeds

Career Aspirations:
Process engineer, R&D engineer or research engineer involving the characterisation and rheology of particulate suspensions. Previous paid work included the investigation of the erosion effects of cohesive sediments during submerged jet impingement and the initial design of a laboratory scale liquid/liquid extraction rig.

Progress:

- Current PhD research focuses on using a quartz crystal microbalance for the measurement of concentrated suspension rheology.
- The device is able to characterise rheology in-situ, where the changes in the resonator's frequency and resistance response can be compared to the suspension shear yield stress as measured by rotational vane viscometry.
- Current work focuses on changing the crystal surface properties (material coating / roughness) to improve the suspension – crystal contact. This will enhance the usability of the device to include higher yield stresses and a wider range of suspension pH values.

A Life Cycle Approach as a Decision Tool for Waste Management and Decommissioning

ANDREA PAULILLO
PhD Student, University College London

Career Aspirations:
My intention is to keep working in the nuclear field after the completion of my PhD. I would like to have gain experience in the industry first and then decide which path (industry or academic) to undertake. If I could choose, I would probably work for a nuclear startup developing new reactor designs or for a big international organization such as the IAEA or the IEA.

Progress:

- Operationalization of a Mackay-type model for assessing the impact of radioactive discharges.
- Short internship at Sellafield Ltd. for collection of operational data of THORP.

Understanding Actinide Sorption and Binding to Cement Materials

ANTONIA YORKSHIRE
PhD Student, University of Sheffield

Career Aspirations:
My PhD research is concerned with radionuclide interactions with cementitious materials during both interim storage and geological disposal conditions. My interest lies in the topic of radionuclide mobility and migration in the adapting conditions of the wider environment. I envisage that my research background will allow me to further pursue a career in this area after my PhD with companies such as the Environment Agency or Radioactive Waste Management.

Progress

- Synthesis of cement hydrate phases such as C-S-H (Calcium-Silicate-Hydrates) and characterisation using X-ray diffraction, for use in sorption studies with various radionuclides including U, Np and Tc.
- Making up cement blends relevant to ILW encapsulation, such as blast furnace slag and fly ash, with solutions of aqueous uranium to determine the structural incorporation of uranium into hydrate phases using scanning electron microscopy and X-ray diffraction.
- Initial sorption studies using hydrotalcite (a blast furnace slag hydrate phase) and U(VI) to determine uranium uptake using liquid scintillation counting.

Modelling the Surface Chemistry of PuO_2 at the Molecular Level

DR. BENGT TEGNER
PDRA, Manchester

Career Aspirations:
So far I've completed a PhD within a Marie Curie Network working in collaboration both with industry and academia. I've also spent a year in industry prior to joining DISTINCTIVE as a post-doc. Ideally I'd like to obtain a fellowship which would allow me to continue working in academia on problems relevant to the nuclear industry. Alternatively, I'd like to pursue a career working in nuclear regulation as a subject matter expert, either on the industry side or the government side.
Progress:

- Calculated water desorption temperatures for pristine UO_2 and PuO_2 surfaces, comparing molecular and dissociative adsorption for the (111), (110) and (100) surfaces. The results are being written up and about to be submitted to a peer-reviewed journal.
- Presented a paper at the DISTINCTIVE session at the 2016 Waste Management Conference in Phoenix, Arizona, USA.
- Presented a poster at the RSC Northern Postdoctoral Meeting in Huddersfield
- Attended the DISTINCTIVE Public Engagement and Media Workshop in Sheffield, UK.
- Will give an oral presentation at the conference Plutonium Futures 2016 in Baden-Baden, Germany.

Grain Boundary Damage Mechanisms in Strained AGR Cladding Under Irradiation

CHIARA BARCELLINI
PhD Student, University of Manchester

Career Aspirations:
My career at the moment is mainly academic. I am trying to develop a very deep knowledge of the issues related to irradiated structural materials and to learn as much as I can about the techniques used for the characterisation of materials, such as analytical electron microscopy. I would also like to gain some experience in public engagement, since in the future I would like to work in this sector. I would like to become able to explain to the general public in simple terms science-related topics, especially the nuclear ones. Nowadays, there is still a lot of misinformation about nuclear-related issues and I would like to help fill this gap.

Progress:

- Irradiation of two specimens of 20Cr25Ni Nb-stabilised stainless steel with 21MeV iron ions at 400°C up to 1.36dpa and 0.23dpa.
- New material received from NNL: a plate of 20Cr25Ni Nb-stabilised stainless steel, a plate of 20Cr25Ni Ti-stabilised stainless steel and an AGR cladding tube.
- Started the microscopic characterisation of the new materials received.
- Poster presentation at the NEA International Workshop on Structural Materials for Innovative Nuclear System (Manchester, 11-14 July 2016).

Novel Ion Exchange Materials

DR. EVIN (TZU-YU) CHEN
PDRA, University of Birmingham

Career Aspirations:
I have developed strong interests in nuclear waste treatment and would like to pursue a career in the field. For short term plans, I aim to enhance my own expertise in the field of ion exchange and immobilisation, and attend conferences to get myself known. My goal now is to find a research role in the nuclear industry where I can grow and take on new challenges over time.
Ultimately, I'd like to assume more management responsibilities, and work in national or international organisations where I'll have opportunities to develop my skills, take on interesting projects, and work with world-recognised experts in the field.
Progress:
Previous work has shown the flexibility in Sn-umbite ($K_2SnSi_3O_9 \cdot H_2O$) to incorporate metal substitution in the framework and the significant increase of ion exchange property to both Sr and Cs due to the modification. We were awarded synchrotron and neutron bean time for the structural studies of Cs/Sr exchanged umbites to understand the effect of substitution on the ion exchange properties. Cs and Sr-exchanged umbite materials have been hot isostatic pressed to produce ceramic wasteforms for investigation of phase assembly and chemical durability to provide an effective and durable means of immobilising Cs and Sr for disposal.

Novel Ceramic Waste Forms for Cs and Sr Encapsulation

GEORGE DAY
PhD Student, University of Birmingham

Career Aspirations:
On the completion of my PhD I intend to apply for a number of nuclear based jobs including suitable ones at the NNL, Sellafield Ltd and also the nuclear graduates scheme.

I have also considered the option of further nuclear associated academic research and applying to post doctoral positions in the UK or abroad.

Progress:

- Further computational studies have been carried out in order to determine the thermodynamic stability of Ba doped $Cs_2TiNb_6O_{18}$.
- Additional synthesis including hot isostatic pressing of $Cs_2TiNb_6O_{18}$ based materials which are undergoing analysis using a range of techniques such as powder x-ray diffraction, X-ray fluorescence spectroscopy and electron microscopy to confirm whether Ba is incorporated in the material.
- Aqueous leach testing of HIPed spent IONSIV waste forms.

Production of Real-time Segmented as-Built CAD Models

HENRY CHENG ZHAO
PhD Student, University of Birmingham

Career Aspirations:
I am a first year PhD student in the department of Computer Science, University of Birmingham. My research area is 3D SLAM/Reconstruction. I have a strong interest in my research and plan to do become a research fellow after I get my PhD degree. I ultimately want to use what I have learned to solve the real industrial problems to improve the human life. So, I prefer work in the industrial company in the future.

Progress:

- My research topic is Active semantic SLAM on robot arm for nuclear waste. This topic include three part: 3D SLAM/reconstruction, semantic labelling, active SLAM. During my first year PhD study, I mainly focused on 3D SLAM/ reconstruction part. I did some literature review work, implemented a 3D SLAM myself and make a quantitative analysis of shiny pipe reconstruction using different SLAM algorithm. You can find two relative report before:
- How to do 3D RGBD SLAM step by step.
- Quantitative analysis of shiny object reconstruction using different reconstruction methods.

Enhanced Shear Micro- and Ultra-filtration Without Recycle Pumping

KEITH SCHOU
PhD Student, Loughborough University

Career aspirations:
To work in a position which is interpersonal, technically challenging, makes use of the skills developed from my experience and qualifications and allows a healthy work/life balance.

Progress:

- Developed a first principle model of enhanced shear micro- and ultra- filtration with shear. From volumetric cake concentration, rheological properties of cake and the Sauter mean of the suspension for near spherical, mineral suspensions.
- Tested this model against experimental data, and shown it to be effective with calcium carbonate (calcite).
- Determined the form of shear applied does not determine filter cake deposit, and hence the pseudo steady state flux, but the magnitude does.
- Determined the cake is the determining factor in micro- and ultra- filtration, both in the particle rejection and the pseudo steady state flux across the filter.

Thermal Treatment of PCM and ILW

LUKE BOAST
PhD Student, University of Sheffield

Career Aspirations:
BEng Materials Science and Engineering (with a year in industry)

My career aspiration is a well-paid job in industry, with opportunity to travel.

Progress:

- In the process of analysing the samples obtained from a recent placement to be used in my thesis
- Need to repeat a few experiments and begin to tie all my work together as I am entering 4th year.

Understanding the Interfacial Interactions of Plutonium Dioxide with Water

DR LUKE JONES
PDRA, University of Manchester

Career Aspirations:
My career to date consists of a Chemistry degree attained at Manchester with a year spent at AMEC Nuclear. This placement involved large scale non-active experiments for a variety of customers including Sellafield and DSRL. Following my degree, I achieved my PhD and DISTINCTIVE PDRA as a member of the University of Manchester Radiation Science Team. As part of this PDRA, experiments using radioisotopes will be undertaken at NNL-CL. Further career aspirations would be to continue in this area of research using active material and facilities to help with fuel cycle and storage demands for current and future nuclear power generation.
Progress:

- Continued training and inductions to gain access to NNL's Central Laboratory (CL)
- Proposal submitted to NDA for facilities access to NNL's CL
- Further experiments undertaken utilising DCF Ion accelerator and 60Co irradiator
- Ongoing commissioning of reaction cell to undertake PuO_2 experiments at NNL-CL
- Oral presentation at Plutonium Futures - The Science 2016 conference in Baden-Baden

In-situ Ground Contaminent Containment

DR. MATTEO PEDROTTI
PDRA, University of Strathclyde

Progress:
Fundamental understanding of factors controlling colloidal silica gelation.

- Experimental characterisation of the colloidal silica grout examining gelation behaviour in conditions of varying pH, electrolyte concentration, cation valency, molar mass, silica particle concentration and temperature.
- Development of an analytical model to control and predict gel time of colloidal silica grout (paper submitted to Tunnelling and Underground Space Technology).
- Preliminary testing carried out using ERT technology to monitor colloidal silica grout injection in collaboration with Oliver Kuras, BGS.
- Investigation on the consolidation behaviour of the colloidal silica grout.
- Investigation on the ultimate shear resistance of the colloidal silica grout
- Investigation on the water retention behaviour of the colloidal silica grout
- Medium laboratory scale injection preliminary test
- Preliminary results on the finite element modelling on the injection of colloidal silica grout in a porous media
- Preliminary test on silica grout-radionuclide interactions, with a focus on the impact on radionuclide mobility via sorption/desorption experimental tests.

Gas Retention and Release from Nuclear Legacy Waste

MICHAEL JOHNSON
PhD Student, University of Leeds

Career Aspirations:
Over the last three years I've really enjoyed the challenge of research as well as helping to teach modules in thermodynamics and reaction engineering. I'm very interested in pursuing further research either as a PDRA or in a Research and Development position in industry. I have experience in rheology, particulate suspensions, dewatering, x-ray tomography and heat transfer, but I'm open to exploring interesting new chemical engineering challenges at the end of my PhD.
Progress:

- We have published research on the aggregate structure and settling behaviour of Magnox corrosion products
- New high resolution x-ray tomography data of bubbles in consolidated nuclear legacy waste was obtained during collaboration work at the University of Queensland.
- I presented my research at Chemeca 2016 in Adelaide.
- A new phase of work was commenced on the influence of bubble retention on the flow behaviour of magnesium hydroxide soft sediments.

Computational Modelling of PuO_2 Ageing and Fuel Residues

NATHAN PALMER
PhD Student, University of Birmingham

Career Aspirations:
I would very much like to have a career in the nuclear industry. As a scientist, I would like to use my skills and knowledge in a professional job working for nuclear companies such as NNL and Sellafield Ltd. My PhD involves computational modelling of PuO_2 ageing for storage applications. This is a stepping stone to me being actively involved in the UK nuclear industry which has big future ahead of it, with many new reactors being proposed and the many challenges involved relating to nuclear waste management and decommissioning.
Progress:

- Using potentials, static lattice simulations have predicted a range of novel defect energies, both intrinsic and extrinsic involving helium in the bulk lattice.
- MOX fuel has been modelled using a supercell method and mean field approach in the simulations, to predict structural and mechanical properties varying the plutonium concentration.
- Surface simulations of PuO_2 are underway to investigate (100), (110) and (111) plane stabilities with and without defects of relevance to storage.
- Attendance of the CCP5 and Hermes 2016 Summer Schools, to learn about computational techniques and presenting skills, which will be applied in this project.

Autonomous Systems for Nuclear Decommissioning

OLUSOLA AYOOLA
PhD Student, University of Manchester

Career Aspirations:
To be a researcher in a highly reputable institution or as a concept developer in a nuclear or energy related Industry.
Basic research interests are; control systems design, instrumentation development and data quality analysis and protocol optimisation.

Progress:

- In-house construction of a spinning Riffler used for unbiased sample distribution - completed
- Identification of influence factors contributing to sampling and analytical uncertainties in sludge characterisation - completed
- Achievement: The quantification and harmonisation of measurement uncertainties due to influence factors in sludge sampling and analysis protocols - completed
- Investigation of ultrasonic spectroscopy as a feasible solution for an optimised sludge characterisation protocol (in situ) – in progress
- NNL generously supported the research by providing access to the dry laboratory for experimental works. This is highly appreciated.

New Ion Exchange Materials For Effluent Clean-up

RYAN GEORGE
PhD Student, University of Birmingham

Career Aspirations:
A number of different opportunities have been presented to me throughout the course of my PhD, both at the University of Birmingham and through the DISTINCTIVE consortium. These experiences have provided me with the foundations needed to further my nuclear career, be it in industry or academia. Further opportunities that I am looking for are greater access to on-site visits, short term placements or summer schools. More information related to careers in the nuclear industry would also be very useful.

Progress:

- Ion exchange properties of Zr-Ge-Umbite explored; the material shows some degree of caesium and strontium uptake.
- Successful doping of niobium into Zr-Ge-Umbite; subsequent ion exchange experiments show a much higher uptake then the parent material.
- Material flexibility explored by replacing zirconium for other 4+ species with both partial and total substitution.
- Replacement of 4+ zirconium with a combination of 3+/5+ cations which further tests the flexibility of the Zr-Ge-umbite framework with extra focus on the impact this has on ion exchange properties.

Ceramic Materials for Actinide Disposition

DR. SHI-KUAN SUN
PDRA, University of Sheffield

Career aspirations:
I received my PhD of Materials Physics and Chemistry in Shanghai Institute of Ceramics, China on 2012. I then worked as PDRA in Hokkaido University, Japan from 2012 to 2014. From January 2015, I moved to University of Sheffield and started to work as a PDRA member in DISTINCTIVE Consortium.
My career goal is to acquire the necessary training and knowledge to become a leading independent investigator in materials science. I am looking for further experience on either academic or industrial position, where I can obtain the sufficient knowledge on the nuclear waste (HLW) immobilisation.
Progress:

- XPS on the Uranium betafite has been done to confirm the oxidation state of uranium, in comparison with the results obtained from XAS.
- Based on the previous experiment, further irradiation has been performed on the zirconolite glass-ceramics. Work is continuing on the investigation of the critical irradiation condition by the combination of SEM, AFM and VSI.
- A carefully-designed leaching test is on-going on the zirconolite glass-ceramics to compare the dissolution behaviours of glass and ceramic phases.

Options for Exotic Carbide Fuels

CLAUDIA GASPARRINI
PhD Student, Imperial College

Career Aspirations:
I hope to have completed my PhD, which investigates the oxidation of ceramic materials including carbide nuclear fuels, within the near future. During my studies I have performed research on active materials (depleted uranium carbide, UC) in European nuclear top facilities and I feel very grateful for this opportunity. I intend to continue my career by doing research in the nuclear field therefore I will search for a post doctoral position. I found it very intriguing studying nuclear fuels and trying to assess industrial issues from a university perspective and I hope this can be a possibility again in the future.
Progress:

- Experimental work on UC was performed at NNL Springfields
- Collaboration set up with and experimental work on UC performed at ICSM (Institute for the Separation Chemistry), Marcoule, France
- Winner of the Best PhD Student Oral Presentation Award at the 2nd DISTINCTIVE Annual Meeting (19-20th of April 2016)
- Winner of the Best Scientific Content of a Poster at Imperial College Materials Postgraduate Research Day (21st March 2016)
- "Oxidation of Carbides Including Carbide Nuclear Fuels" presented at the 10th European Nuclear Education Network PhD Event & Prize 2016, Warsaw, Poland

Magnetic Nanoparticles for Waste Separation or Sequestration

ELEONORA CALI
PhD Student, Imperial College

Career Aspirations:

I'm not sure if I want to work in the industry straight away or if I'd rather do a postdoc and consider a career in academia. If my research project would generate a postdoc that would allow me to continue the work I'm currently doing I would be happy to do that.

Progress:

- Currently working on a paper that would be hopefully published in early 2017
- DISTINCTIVE Public Engagement course attended in Sheffield (22-24th June)
- Abstract accepted for an oral presentation at MS&T16 Conference in Salt Lake City (UTAH USA), (23-27 October 2016)
- Adsorption tests with radioactive materials undertaken in Loughborough University's Radiochemistry laboratory during the past 3 months.

Understanding Surface Species and Interactions Between Adsorbed Chloride and Water on Stored PuO_2

SOPHIE SUTHERLAND-HARPER
PhD Student, University of Manchester

Career Aspirations:

Research in radiochemistry, investigating previously untouched topics in an environment where I can use all the synthetic and analytical skills I will acquire as part of this project and develop them further so that I can get the best out of my data. Using many pieces of equipment would give me a healthy variety and balance in my work, so that I can occupy all of my time practically and understand my research in greater detail.

Progress:

- Submitted 1st year transfer report and currently editing a paper for publication.
- Completed fumehood and glovebox training at NNL and will be SQEPed in due course.
- Synthesised CeO_2 thin films on a titanium substrate for XPS.
- Carrying out relative humidity experiments, by storing CeO_2 powders under atmospheres of different relative humidities before exposing them to HCl gas.
- Carried out heat treatment and Baskerville experiments on Magnox PuO_2 at NNL.

Modelling Hydrogen Generation from Radioactive Sludges

CONRAD JOHNSTON
PhD Student, Queen's University Belfast

Career Aspirations:

Having now worked in nuclear generation, and conducted research in decommissioning, I'm interested in opportunities across the whole nuclear life-cycle. I'm interested in new research projects, be that in industry or academia, but also design work, as my background is chemical engineering. My preference is likely to be for positions in the UK and Ireland, but I'm also searching for opportunities in North America and Europe.

Progress:

- An article about excess electron defects in brucite mineral has been prepared for submission.
- A study has been designed with our experimental partners to examine molecular hydrogen diffusion in brucite following irradiation.
- Work is continuing examining bond breaking in brucite using metadynamics in the wake of interesting molecular dynamics results.

Simulating Radiation Damage in Cement

RYAN KAVANAGH
PhD Student, Queen's University Belfast

Career Aspirations:
My current career goals are to successfully complete my PhD and move into research in the field of radiation and its effects on matter or cement technologies. My ideal career is a research position directly with groups in the industry or collaborating university groups that are also interested in cement characterisation and development of suitable wasteform technologies. The UK nuclear industry is an excellent place to get involved in both research fields and reach my career aspirations.

Progress:

- Prior work this year utilized the Marseilles atomistic model for cement to determine the effects of γ radiation on cement wasteforms. While this work has proven useful, a more suitable model is required to provide critical understanding of cement at the atomic level.
- Current efforts are focused on the development of a "defect tobermorite" model to successfully model cement at the nanoscale. Efforts consist of a combined quantum mechanical and classical molecular mechanic study to elucidate the structure of Tobermorite 11, a material thought to closely describe the properties of cement.

Development of Glass-ceramics for Pu Disposition using Hot Isostatic Pressing

STEPHANIE THORNBER
PhD Researcher, University of Sheffield

Career aspirations:

I want a career that challenges me and allows me to further develop my skill set in different areas of the industry. I hope to progress to different roles and find the place where I can truly strive. I don't yet know where that is but I hope for a satisfying career that I enjoy, have opportunities to travel and have a good work-home life balance whilst being financially comfortable and stable.

Progress:

- CeO_2 has been used as an analogue for PuO_2 in waste incorporation experiments. Ce partitioning into the crystalline phases has been shown to be preferential over incorporation into the glass phase agreeing with the literature. Ce L3 XANES looked at the oxidation state of Ce to determine the ratio of Ce3/4+ in each sample. Further samples are investigating the redox effect of the stainless steel canisters and control of oxygen fugacity on the oxidation state of the Ce.
- Stephanie is in the final stages of her PhD with focus now turning to thesis writing.

Nano-cracking of Cement Phases: Reactivity and Dissolution

LUCA RIZZO
PhD Student, University of Strathclyde

Career Aspirations:

After one year of experience as a PhD. Student, I am enjoying my academic research project since it involves many different aspects. But I would be interested as well in dealing with technical/practical aspects related to industries/companies in the environmental/energetic field.

Progress:

In one year of experience as PhD Student I could start developing individual skills in the research field: from writing a literature review, to schematize/write a paper but generally to try to solve problems and think about what is needed for your research by yourself, optimizing timing the most. I wrote a draft of a review paper that me and my supervisor are planning to publish about AFM studies on cement and cement related materials, and I developed skills with the Atomic Force Microscopy which will allow me to obtain important data during the rest of my PhD.

Crack Sealing and Water Transport

RICCARDO MADDALENA
PhD Student, University of Strathclyde

Career Aspirations:
I gained a lot of experience on material chemistry laboratory, analytical techniques and problem solving. I would like to join a R&D department of a company, cement manufacturing, cement chemistry, ground and soil remediation. Another career aspiration option would be a post-doctoral position on a project on radionuclides interaction with cement and concrete or cement manufacturing for extreme operation environmental conditions

Progress:

- One article on "nano-silica injection on cement for crack sealing" has been submitted to an international journal. A novel non-invasive technique has been developed and tested.
- One article on "novel synthesis of C-S-H mineral phases" has been submitted to an international journal. The studied synthesis process allows the possibility to produce C-S-H gel, the most import binding phase in hydrated cement and concrete.
- New interesting progress has been made on the interaction of C-S-H phases and radionuclides, at standard and/or extreme environmental conditions.

Development of Novel, Low Cost Biomineral Permeable Reactive Barriers for Radionuclide Remediation

THOMAS MULLAN
PhD Researcher, University of Strathclyde

Career aspirations:

My current aspirations are to work towards pursuing academia and research as a career, particularly with a focus on engineered solutions to environments contaminated by radionuclides. I am interested in further developing my skills within analytical chemistry and the engineering aspects of remediation technologies.

Progress:

- Model microorganisms have been purchased and studied, including understanding optimum growth conditions
- Work has begun on biomineralisation experiments
- Attended and presented a poster at the Goldschmidt geochemistry conference in Japan
- Currently preparing for first year progress review

Publications

The following are some of the peer-reviewed papers and articles that have been published since the programme started in February 2014.

Makkos E., Kerridge A., & Kaltsoyannis N., *The importance of second shell effects in the simulation of hydrated Sr2+ hydroxide complexes.* Dalton Transactions, vol. 44, pp. 11572-11581.2015.
DOI: 10.1039/c5dt01110h

Maddrell E., Thornber S.M., & Hyatt N. C., *The influence of glass composition on crystalline phase stability in glass-ceramic wasteforms.* Journal of Nuclear Materials, vol. 456, pp. 461-466.2015.
DOI: 10.1016/j.jnucmat.2014.10.010

Springell R. et al. (incl. Rennie S., Costelle L., Darnbrough J., Sims H E., & Scott T.) *Water corrosion of spent nuclear fuel: radiolysis driven dissolution at the UO_2/water interface.* Faraday Discuss., vol. 180, pp. 301-311.2015.
DOI: 10.1039/c4fd00254g

Blundell E.L.C.J., Mayne L.J., Billinge E.R. & Platt M. *Emergence of tunable resistive pulse sensing as a biosensor.* Analytical Methods, vol. 7(17), pp. 7055-7066.
DOI: 10.1039/C4AY03023K

Frankel G. et al. (incl. Springell R.) *Localised corrosion: general discussion.* Faraday Discuss., vol. 180, pp. 381-414.2015.
DOI: 10.1039/c5fd90046h

WE Lee, MI Ojovan and GA Thomas, *The UK's Radioactive Waste and Waste Management Programme*, in Advances in Materials Science for Environmental and Energy Technology III: Edited by T Ohji et al., Ceramic Transactions 250 157-175 (2014).

MI Ojovan and WE Lee, *About U(t) Form of pH-dependence of Glass Corrosion Rates at Zero Surface to Volume Ratio*,pp. 153-161 in Proc. MRS Symp. 1744, Scientific Basis for Nuclear Waste Management XXXVIII, Boston, USA (2015).

M Fairweather, SR Biggs, AME Ward, C Boxall, NDM Evans, JA Hriljac, NC Hyatt, N Kaltsoyannis, WE Lee, RJ Lunn, SM Pimblott and TB Scott, *Collaborative Research Programme in Decommissioning, Immobilisation and Storage Solutions for Nuclear Waste Inventories (DISTINCTIVE)*,"paper 16466 in WM2016 Proc. Waste Management Conf. Phoenix, AZ, USA 2016.

RK Chinnam, C Hutchison, D Pletser and WE Lee, *Degradation of Simulated HLW Glass and International Simple Glass Immersed Partially in Water*, in Proc. Waste Management Conf. Phoenix, AZ, USA 2016.

D Pletser, RK Chinnam, M Kamoshida and WE Lee, *Low Melting temperature Glass for Immobilisation of Contaminated Zeolitic Ion Exchangers from Fukushima*, in Proc. Waste Management Conf. Phoenix, AZ, USA 2016.

D Pletser, RK Chinnam, M Kamoshida and WE Lee, *Immobilisation Process for Contaminated Zeolite Ion Exchangers from Fukushima*, in MRS Symp. Proc. Scientific Basis for Nuclear Waste Management XXXIX, Montpelier, France (2016).

RK Chinnam, C Hutchison, D Pletser and WE Lee, *Degradation of International Simple Glass Cracks and Surface*, in MRS Symp. Proc. Scientific Basis for Nuclear Waste Management XXXIX, Montpelier, France (2016).

C Gasparinni, R Podor, D Horlait and WE Lee, *Zirconium Carbide Oxidation: Maltese Cross Formation and Interface Characterisation*, Oxidation of Metals (2016).

Joseph P.W. Wellington, Andrew Kerridge, Jonathan Austin, Nikolas Kaltsoyannis, *Electronic structure of bulk AnO2 (An ¼ U, Np, Pu) and wateradsorption on the (111) and (110) surfaces of UO2 and PuO2 from hybrid density functional theory within the periodic electrostaticembedded cluster method* Journal of Nuclear Materials 482 (2016) 124-134

Eszter Makkos, Andrew Kerridge, Jonathan Austin, and Nikolas Kaltsoyannis *Ionic adsorption on the brucite (0001) surface: A periodic electrostatic embedded cluster method study* The Journal of Chemical Physics 145, 204708 (2016); DOI: 10.1063/1.4968035

Michael Johnson, Jeffrey Peakall, Michael Fairweather, Simon Biggs, David Harbottle, and Timothy N. Hunter, *Characterization of Multiple Hindered Settling Regimes in Aggregated Mineral Suspensions*, Industrial & Engineering Chemistry Research 2016 55 (37), 9983-9993
DOI: 10.1021/acs.iecr.6b02383

Tzu-Yu Chen, Ewan R. Maddrell, Neil C. Hyatt,and Joseph A. Hriljac, *A Potential Wasteform for Cs Immobilization: Synthesis, StructureDetermination, and Aqueous Durability of Cs2TiNb6O18*
DOI: 10.1021/acs.inorgchem.6b01826

S.M. Thornber, M.C. Stennett and N.C. Hyatt, *Investigation of Ce incorporation in zirconolite glass-ceramics for UK plutonium disposition*, MRS Advances, in press (2016).

N.C. Hyatt, *Plutonium management policy in the United Kingdom: The need for a dual track strategy*, Energy Policy, in press (2016). http://dx.
DOI: 10.1016/j.enpol.2016.08.033

Events

Annual Meeting - 2017

5th - 6th April 2017, York

Registration for the 3rd Annual Meeting will open in January. The conference will be held at the National Railway Museum in York. Contributions will be made by all DISTINCTIVE researchers, and representatives from industry.

Theme Meetings - 2017

November 2017

Theme meetings for 2017 will be held over 2 days in Cumbria and will take place during November.

Please check the DISTINCTIVE website for updates.

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