



DISTINCTIVE Goes International

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

It's a very exciting time for the consortium.

Next month a cohort of DISTINCTIVE members, including myself, will travel to Phoenix, Arizona, USA, to attend the 2016 Waste Management Conference.

This is the first time that the programme will have a presence at an overseas event, and we see it as a fantastic opportunity to further develop the relationships that have been initiated through the International Advisory Group, and to explore options for future collaboration. We hope to raise the profile of the programme within national research laboratories and universities for mutual benefit.

We will have a dedicated technical session at the event with eight contributions being made by our academics, researchers and members of the IAG. We also have an additional eight contributions being made throughout the conference. More details on our presence can be found on Pages 7 and 8. We will ensure that we give you an overview of the conference, including details of the related publications, in the next edition

of the newsletter!

We are also quickly approaching the 2nd Annual Meeting that will be held in Bristol in April. We are now at the mid-point in the programme, and most of our researchers have now started generating results. The event will follow a similar format as last year, with presentations across our four technical themes from PhD students and PDRAs.

If you have yet to register for this event, I encourage you to do so as the limited number of spaces are filling up quickly!

For this edition of the newsletter, we asked our researchers to write a project 'wish list' to indicate where further collaborations with industry and other academics outside the consortium might be beneficial. You can find these short articles inside.

We look forward to seeing you in April!

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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.

So far, we have held two calls, one in January 2015 and one in July 2015. To-date, five sub-projects have been supported. Here the successful candidates summarise the proposed work:

Round 1

Investigation of Silica Grout-radionuclide Interactions: Impact on Radionuclide Mobility and Silica Gelation

Dr. Matteo Pedrotti – University of Strathclyde

One of the main objects of the DISTINCTIVE Work Package 4 is to develop in-situ ground barriers that could act as a 'second skin' surrounding on-site structures for prevention of subsurface radionuclide migration using silica based grouts. Silica grouts will be injected into contaminated areas. Therefore it is crucial that the silica-radionuclides interactions are well understood to ensure that the silica grout does not increase radionuclide mobility and that, ultimately, it reduces the hydraulic permeability, in the presence of radionuclides, down to values of $\sim 10^{-9}$ m/s, thus preventing radionuclide migration. The two aims for this active sub-project are:

(1) To determine the effect of radionuclides on silica gelation and changes to hydraulic conductivity of soil.

- The presence of radionuclides may prevent, accelerate or retard the gelation of silica and therefore affect the final permeability of the grouted soil.

(2) To determine the effect of colloidal silica injection and gelation on radionuclide speciation and mobility

- Interactions of silica colloids with sorbed radionuclides may cause desorption of the radioisotope from soils in situ and hence increase radionuclide mobility

- Increases in groundwater flow through injection of the silica grout may enhance radionuclide mobility.

The Corrosion of Spent Nuclear Fuel

Dr. Leila Costelle – University of Bristol

In the present project, we synthesise thin film samples of uranium dioxide-based materials and expose their surfaces to a range of chemical conditions and radiation fields in order to closely mimic the environments expected to be found at the surface of spent nuclear fuel (SNF). This is of great importance as we currently rely on calculations of these processes to predict the mid- and long-term effects of our nuclear waste containment strategies. We use a range of techniques in order to probe the dynamic changes to the fuel's structural integrity and to measure the dissolution products. This combination of modern synthesis techniques, characterisation and cutting-edge large facilities research, will have significant impact on our understanding of SNF behaviour during storage and disposal, and the arising experimental results will be used as important parametric input for calculations of the likely long-term degradation of SNF in variety of potential storage and disposal scenarios.

An Investigation of Wasteform Evolution During Wet-recovery and Drying of SNF

Dr. James Darnbrough – University of Bristol

Bristol's application for Active Research Fund is based around the key issue for nuclear fuels of thermal conductivity. The question of how easily a material can dissipate heat has implications throughout the fuel cycle. This ranges from the efficiency of the fuel at heating water, making steam which turns the turbines producing electricity, to accident tolerance, what happens when cooling is lost, and to how the material acts after life in a reactor, how is it safe to store or dispose.

Therefore funds were sort to create a simple device to measure the thermal conductivity of samples produced to mimic the fuel at different stages throughout life and focusing on spent fuel to help inform safe long term geological storage. This information will elucidate some of the key challenges in the nuclear industry and indicate a root towards a safe treatment of future and legacy fuels.

Round 2

Building a Portable Ultra-high Vacuum (UHV) Chamber for Active Samples

Dr. Leila Costelle – University of Bristol

The aim of this project is to build a portable sample storage device with ultra-high and inert gas overpressure and suitcase capabilities. The system will allow us to transfer active samples between different equipment and transport to beam lines, without getting them exposed to ambient conditions.

Fission Product Effects on Spent Fuel Corrosion

Dr. James Darnbrough – University of Bristol

This project will be the next step, building on work conducted on pristine samples, to interrogate the reactions happening at the surface of nuclear fuel after life in the reactor. During the time in the reactor the fuel undergoes many changes through radiation damage and fission reactions. The range and amounts of fission products are well understood; however, the effect of these daughter products on the dissolution and reactions at the surfaces of spent nuclear fuels requires investigation for the considerations required when dealing with safe long-term storage.

In using a de novo approach to researching this problem, we are able to engineer a simulation sample with complete control over the structure (through growth at Bristol), contamination/implantation (through work at the Surrey University Ion Beam Centre) and radiation field (through synchrotron flux X-rays at Diamond). This allows investigation into potential corrosion and other key factors for long-term storage with a system that is controlled and safe to give results that can inform solutions to real problems.

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

3rd Call Announced

The 3rd Call was announced on Wednesday 3rd February 2016.

It is open to all PDRA's who are directly incurred posts on the EPSRC grant EP/L014041/1. The call is not open to PhD researchers that are associated with the programme.

The deadline for email submission is Friday 25th March 2016.

The call document and proposal template can be downloaded from our website: <http://goo.gl/axUFz2>

For more information, please contact Abby Ward (A.M.E.Ward@leeds.ac.uk) or Prof. Simon Pimblott (simon.pimblott@manchester.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).

Dr. Costelle and Dr. Darnbrough's PDRA project is titled "An Investigation of Wasteform Evolution During Wet-recovery and Drying of SNF". Their lead supervisor is Dr. Ross Springell (phrss@bristol.ac.uk).



Waste Management Conference 2016

DISTINCTIVE will have a noteworthy presence at the upcoming Waste Management Conference

The annual Waste Management (WM) Conference is an international event for the management of radioactive materials and related topics.

With the help of Dr. Barry Lennox (University of Manchester), Keith Miller (NNL) and members of our International Advisory Group (IAG), DISTINCTIVE has secured a dedicated technical session at this event.

The session consists of eight presentations that cover all aspects of the programme. It will be co-chaired by Prof. Ian Pegg (The Catholic University of America, IAG Chair) and Mike Angus (NNL, DISTINCTIVE Lead).

Furthermore, an additional eight papers have been submitted to the event by DISTINCTIVE researchers. A flyer that has been circulated through our contact networks can be found on the following page. It details all contributions being made by the consortium.

If you plan to go to this event, please come and say hello at the DISTINCTIVE social, and attend the various sessions highlighted.

DISTINCTIVE Students Win Waste Management Triple

DISTINCTIVE's PhD researchers Luke Boast, Stephanie Thornber (University of Sheffield) and Dimitri Pletser (Imperial College London) have been awarded the Roy G. Post Foundation Scholarship to attend and present at the upcoming conference.

Roy G. Post was the founding chief executive of WM Symposia, the sponsor of the annual international Waste Management Conference. The Roy G. Post Foundation is a non-profit organization formed by his students, peers and protégés to provide scholarships to outstanding students to develop careers in the safe management of nuclear materials and to participate in the WM Conference. Steph, Luke and Dimitri will be presented with their Scholarship Awards, in the amount of \$5,000, at the WM2016 Conference Honors and Awards Luncheon on Tuesday, March 8, 2016 in the Phoenix Convention Center. The Foundation is also generously supporting travel reimbursement to the meeting and complimentary registration and accommodation.

Luke is working on thermal treatment and vitrification of plutonium contaminated materials, and Steph is working on glass-ceramic formulations for disposition of plutonium residues and stockpile material by hot isostatic pressing. Dimitri is working on glass composite materials for Fukushima ILW immobilisation.

NNL WM2016 Bursary Winner Announced

The competition winner was Andre Botha, PhD researcher at the University of Leeds, with the abstract titled "A Novel Technology for Complex Rheological Measurements".

To encourage increased collaboration, NNL kindly offered a £2000 bursary to support the attendance of a DISTINCTIVE PhD candidate, or postdoctoral researcher, at the Waste Management Conference.

Researchers were asked to submit an abstract for a proposed joint paper with NNL and university authors. The abstracts were reviewed by a panel at NNL, and the criteria included the technical quality of the abstract, the level of interest that the subject is likely to generate at the conference and the extent of collaboration with industry supervisors.

The paper will be presented in the dedicated DISTINCTIVE WM session.



092 EPSRC DISTINCTIVE Research Programme - Wednesday 9th March 13:30 - 17:00 - 106C

DISTINCTIVE is a multi-disciplinary collaboration of 10 universities and three key industry partners from across the UK's civil nuclear sector. Our world-class research programme focuses on the area of nuclear decommissioning and waste management.

Session Structure:

- Collaborative Research Programme in Decommissioning, Immobilisation and Storage Solutions for Nuclear Waste Inventories (DISTINCTIVE) (16466)
- Building Effective Collaborations to Bring Innovation into Waste Management and Decommissioning (16477)
- Novel Approaches for the Study of Corrosion and Ageing of Spent Nuclear Fuel (16467)
- Behaviour of Alpha Emitters in Cement (16139)
- Water Interactions with Actinide Oxides from First Principles: A Computational Study (16470)
- The Consolidation of Glass-Ceramic Wasteforms by Hot Isostatic Pressing: Sample Optimisation (16581)
- Is Glass Degradation only a Surface Effect: What Other Forms of Glass Degradation can Influence the Safety of Vitrified Nuclear Waste Disposal? (16474)
- A Novel Technology for Complex Rheological Measurements (16471)

More information about the programme can be found on our website: www.distinctiveconsortium.org

Other DISTINCTIVE-associated presentations:

Modelling the Interaction of Corroded Magnox Surfaces with Nuclear Fission Products (16464)
Poster – Monday – Session 031 – Ms. Eszter Makkos – University College London

In-situ Analysis of Legacy Pond Sludge using Raman Spectroscopy (16296)
Poster - Monday - Session 031 - Ms. Kate Wyness - University of Bristol

Gas Retention and Release from Nuclear Legacy Waste (16449)
Poster – Monday – Session 030B – Mr. Michael Johnson – University of Leeds

Enhanced Sheer Micro and Ultra-Filtration via Filter Oscillation for Increased Flux Operations (16526)
Poster – Monday – Session 030F – Mr. Keith Schou – Loughborough University

Choosing Your Nuclear Fuel Cycle: A Life Cycle Assessment Perspective (16425)
Oral – Tuesday – Session 070 - Mr. Andrea Paulillo – University College London

Embedded Cluster Calculations of Water Adsorption on UO_2 and PuO_2 Surfaces (16503)
Oral - Tuesday - Session 040 - Mr. Joseph Wellington - University College London

Utilising a Novel Acoustic Backscatter Array to Characterise Waste Consolidation and Settling in a Horizontal Flow Clarifier (16051)
Oral – Wednesday – Session 095 – Dr. Timothy Hunter – University of Leeds

Immobilisation Process for Contaminated Zeolitic Ion Exchangers from Fukushima Daiichi (16494)
Oral - Thursday - Session 134 - Mr. Dimitri Pletser - Imperial College London



You are invited to a social in Room 106C immediately after the session. Please take the opportunity to meet the team, to discuss the research presented in more detail, and to explore opportunities for collaboration.

The social has kindly been sponsored by Longenecker & Associates:



University of Sheffield Celebrates Opening of National £3m Nuclear Research Facility

On Wednesday 9th September 2015, The University of Sheffield celebrated the official opening of its new £3m advanced nuclear materials research facility, Materials for Innovative Disposition from Advanced Separations (MIDAS).

This article, including the image, originally appeared on the University of Sheffield website: <https://goo.gl/3dTzYb>

Established as part of a national network of facilities to deliver the UK spent nuclear fuel research programme, MIDAS is jointly funded by the University and The Department of Energy and Climate Change (DECC).

Following the Government's planned expansion of nuclear power in the UK, academics in this national centre for research excellence will be developing new technologies and robust, efficient and environmentally sound strategies for the safe treatment and disposal of radioactive wastes.

More than 120 research experts were given a tour of the new facility and a demonstration of the state-of-the-art laboratory equipment. Visitors

included representatives from the Nuclear Decommissioning Forum – Japan, Idaho National Laboratory – USA, and Areva – France, as well as the UK Department for Energy and Climate Change and Foreign & Commonwealth Office.

Professor Neil Hyatt, Facility Director, said: "Our mission with this facility is to provide a high quality environment for research on radioactive waste and disposal, supported by the world-class expertise we have here in the Department of Materials Science and Engineering at Sheffield. We are already working in collaboration with leading academics in the field and industrial users on a range of national and international research projects."

Over £2.6 M of new funding has been secured for project research at the facility, including collaborations with Pohang University in South Korea.

Energy Minister Andrea Leadsom said: "Britain is a world leader in nuclear power – from construction to generation to waste management – and it is key to our plans to deliver secure, low-carbon electricity and create jobs providing financial security for more hardworking people and their families.

"This Government backs the industries of the future and is committed to maintaining our position as global leaders in nuclear research. These new national facilities at the University of Sheffield will both enhance our thriving scientific and innovative skills base and play an important part in building the Northern Powerhouse."

The University also hosted the Nuclear Academics Discussion Meeting (NADM) 2015 on 8th-9th September. Organised by the EPSRC Nuclear Champion project, the meeting is a forum for the discussion of strategic nuclear challenges in the UK with a focus on how academics and universities can help. The theme for this year was 'new reactor technologies', with talks also being given on the situation in the UK and opportunities available with international partners, including Japan and India.



New national facility at the University of Sheffield for research on radioactive waste and disposal

In addition, experts at the University have won funding from the Economic and Social Research Council (ESRC) for a series of 7 seminars over the next 24 months, looking at the societal issues of storing and disposing of radioactive waste. In partnership with Radioactive Waste Management (RWM) Ltd, part of the Nuclear Decommissioning Authority (NDA), the seminars will bring together different parts of the research and technical communities.

Dr. Susan Molyneux-Hodgson, Senior Lecturer in Sociology, said: "We felt it was timely to provide our academic and technical experts with a new lens through which to consider societal issues around the long term storage of nuclear waste – to inform the current policy considerations both within the UK and abroad".

The nuclear research carried out at the University of Sheffield is part of its Energy2050 initiative, bringing together academics and students actively working on a wide range of energy research.

Additional information

1. For further information on the MIDAS (Materials for Innovative Disposition from Advanced Separations) lab: <http://www.sheffield.ac.uk/materials/centresandfacilities/midas>
2. The labs will form part of the Nuclear National Users Facilities: <http://www.nnuf.ac.uk/>
3. For further information on the ESRC Seminar Series: <http://www.sheffield.ac.uk/socstudies/research/research-seminars/esrc-nuclear-futures>
4. For more information on the University of Sheffield's energy research activities, Energy2050: <http://energy2050.ac.uk/>
5. DECC contributed grant funding of £800k to the MIDAS Facility.

Visit by DECC Chief Scientist Prof. John Loughhead

By Prof. Neil Hyatt, **DISTINCTIVE Co-I and Outreach and Public Engagement Cross-cutting Champion, University of Sheffield**

Prof. John Loughhead, Chief Scientist at the Department of Energy and Climate Change, visited the University of Sheffield on 16th January, to hear about DISTINCTIVE research.

Project Co-Investigator Dr. Claire Corkhill and NDA sponsored PhD candidate Luke Boast presented research on dissolution mechanisms of ILW glasses and demonstrated trace chemical analysis of uranium in cement equilibrated leachates. EPSRC PDRA Dr. Shik-Kuan and NDA sponsored PhD candidate Steph Thornber presented research on immobilisation of actinide wastes, demonstrating Sheffield's unique radiological hot isostatic press capability. Prof. Loughhead also toured the new MIDAS radiochemistry facility, created by co-investment of £3M by DECC and University of Sheffield, which was recently commended by NIRAB on the quality of equipment provision and mechanisms for user collaboration.

Dr. Claire Corkhill and DISTINCTIVE PhD researcher Luke Boast with Prof. John Loughhead, Chief Scientist at DECC



DISTINCTIVE in the House of Commons

By Prof. Neil Hyatt, DISTINCTIVE Co-I and Outreach and Public Engagement Cross-cutting Champion, University of Sheffield

DISTINCTIVE research on immobilisation of plutonium residues and stockpile material was presented at the All Party Parliamentary Group on Nuclear Energy on 25 November 2015, attended by 12 Members of Parliament, 2 Members of the House of Lords, and Angela Leadsom MP - Minister of Energy & Climate Change.

Prof. Neil Hyatt discussed the technical progress made on plutonium immobilisation achieved through DISTINCTIVE and the need for a dual track approach to plutonium management in the UK, to minimise risk, given the significant cost and technical uncertainty associated with both immobilisation and reuse options. NDA sponsored PhD candidate Stephanie Thornber spoke to Members on the fragility of nuclear skills and the need to invest in PhD training to train the leading scientists for the next generation. In her speech, Angela Leadsom confirmed Government's commitment to dealing with the UK's nuclear waste and decommissioning legacy, and highlighted the need for high quality technical evidence to support appraisal of reuse options, such as that produced in our DISTINCTIVE research.

DISTINCTIVE 'Deliberatorium'

In the summer of 2016, Dr Matthew Cotton in the Faculty of Social Sciences at the University of Sheffield will be running an online stakeholder engagement exercise as part of the Pathways to Impact programme of DISTINCTIVE. The aim is capture the broader questions of the management of radioactive waste management in society that are raised by the research within the DISTINCTIVE consortium and beyond.

The online discussion platform goes live in May 2016. It was originally developed at MIT (rather imaginatively) entitled "The Deliberatorium". In essence, a social computing platform designed to help large numbers of people combine their insights to find solutions for complex multi-disciplinary problems. It was originally developed for large scale discussions of climate change policy in the USA, and can readily be applied to this equally politically controversial issue.

Members of the DISTINCTIVE consortium will be strongly encouraged to take part, and engage with a broader network of stakeholders that will also contribute. Contributors will post either issues (technical or social questions that need to be answered), ideas (possible answers for a question), or arguments (statements that support or detract from an idea or argument). These are automatically arranged into branching trees of arguments to produce an 'argument map' of the problems of radwaste management. This setup has the advantage of allowing different users different roles. One user can propose an idea, a second raise an issue concerning how some aspect of that idea can be implemented, and a third propose possible resolutions for that issue. Matthew will be producing a final report based upon the 'argument map' that is generated, and your contributions will contribute to academic social scientific work on social computing and online discussion.

Contributing your ideas will automatically enter you into a prize draw, with monthly prizes to be won for participation.

Any questions or comments, please contact Matthew Cotton: m.cotton@sheffield.ac.uk

Save the Date

Attention all DISTINCTIVE researchers (PhD and PDRA)

We are holding a Media and Public Engagement Summer School at Halifax Hall, Sheffield, between Wednesday 22nd and Thursday 24th June 2016.

The agenda will be announced soon, but the proposed sessions include:

- Public engagement
- Making the most of our media opportunities
- Popular science writing

All DISTINCTIVE researchers (PhD and PDRA) are expected to attend this event, so please 'Save the Date'.



An Invitation...

You are invited to join us at the 2nd **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.

This year's event will be held in Bristol, UK, on Tuesday 19th and Wednesday 20th April.

Registration is free for all partners and associates. The main conference will be held at @Bristol, and the evening dinner on the ss Great Britain.

Spaces are limited and you are advised to register early to avoid disappointment.

To register, please visit: <https://goo.gl/NJbsnl>

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



Agenda

The Leadership Team are delighted to announce our keynote speakers:

- Prof. Rodney Ewing, Stanford University, USA - 'Projecting Risk into the Future: Failure of a Geological Repository and Sinking of the Titanic'
- Dr. John Vienna, PNNL, USA - 'U.S Closed Nuclear Fuel Cycle Waste Management Research'

Almost 20 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
- PuO₂ 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 Abby Ward (A.M.E.Ward@leeds.ac.uk) for more information.

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



Additional

Further information about the event, including links to the venues, can be found on our website: <http://goo.gl/bAU100>

Please check this page regularly for updates.

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

Please note: you must register online to attend.



An Update from Sellafield Ltd.

By Andrew Cooney, Technical Manager, Sellafield Ltd.

Andrew has recently taken over from Debbie Keighley to act as the DISTINCTIVE-Sellafield Lead.



Sellafield Ltd

Site Visit and Robotics

In November, Sellafield Ltd. invited a number of students from the NDA bursary scheme (including those from DISTINCTIVE) to present their work and visit some decommissioning activities on site, organised with the help of NNL. The visit enabled students to meet Sellafield and NNL experts and to promote their work within these organisations.

During the presentations it became apparent that a number of students are working on autonomous objects recognition. Alongside NNL and University of Manchester, we have appointed a PDRA to work on Robotics at Workington. We have asked him to provide an opportunity for these students to collaborate. Similarly, a number of projects involve small USB dosimeters and we would like to be able to understand which are likely to be suitable.

To help such collaborations, we are looking to establish a robotic academic presence on the NDA Knowledge Hub 2.0 that will be released later this year.

Paul Mort (Our Robotics and Autonomous Systems champion) has been developing futuristic scenarios in order to develop programmes and partnerships. He is working with academics, ESPRC and Innovate UK on robotics in harsh environments – watch out for an event in Warrington in April.

I hope to arrange another student visit to the Sellafield site in spring. If any researchers would benefit from this, please send me an email (andrew.s.cooney@sellafieldsites.com).

Game Changer Opportunities

Sellafield Ltd. is currently involved in two game changer programmes:

1. Innovate UK Energy game changer: We are collaborating with the Oil & Gas and Energy sectors to bring in new organisations external to our current supply chains. This includes setting three challenges such as how we combine data from a variety of sources, and sensors to provide an information rich environment for decision making, job planning and execution.

For more information, see website: https://interact.innovateuk.org/competition-display-page/-/asset_publisher/RqEt2AKmEBhi/content/energy-game-changer

2. Sellafield Game Changer Programme: This is a programme delivered in collaboration with NNL and Innovus to turn game changing ideas into proposals. We will make an award of £5k to an organisation to work up a proposal. Further development could be funded via Innovus or other routes. We are supporting this process by publishing a series of 'grand challenges' over the coming months. These will describe the current needs, opportunities and baseline technologies to encourage external organisations to make proposals. Academics are welcome to apply for funding via Innovus. We will shortly be issuing a characterisation 'grand challenge'.

For more information, visit website: <http://www.innovus.org.uk/gamechangers>

Our Website

The DISTINCTIVE University Consortium website was launched in August 2014

The website acts as a repository 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 announcements including calls for the Active Research Fund (PDRAs only).
- Download materials from past events .
- To contact members of the consortium.

www.distinctiveconsortium.org



Wish List

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 Abby Ward (A.M.E.Ward@leed.ac.uk) in the first instance.

These lists, as well as brief summaries of project progress made-to-date, can be found on the following 13 pages.



Development of Characterisation Techniques for ILW Sludges

ANDRE BOTHA
PhD Student, University of Leeds

Wish List:

- Ability to coat titanium dioxide onto a 1 inch diameter quartz crystal microbalance (QCM) silicon/gold crystal using a sputter coating technique.
- The ability to perform streaming potential measurements on gold/quartz 1 inch diameter crystals.

Progress:

- QCM frequency and resistance shift response as a function of sludge concentration.
- QCM frequency and resistance shift response as a function of sludge pH.
- QCM frequency and resistance response as a function of sludge salt concentration.
- A hypothesis explaining the fundamental changes that occur when magnesium hydroxide/magnesium oxide sludge ages. We would like to thank NSG for providing us with the Versamag powder.



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

ANDREA PAULILLO
PhD Student, University College
London

Wish List:

- Disclosure of modelling data regarding the generic Post-Closure Safety Assessment.

Progress:

- Operationalisation of the Risk Assessment methodology for assessing the human impact of ionising radiation.
- Development of an alternative approach based on a MacKay-type model.



Understanding Actinide Sorption and Binding to Cement Materials

ANTONIA YORKSHIRE
PhD Student, University of Sheffield

Wish List:

- Use of active-capable solid state NMR, which is not currently possible in the UK, to analyse cement hydrate phases that are bound to radionuclide species.
- I hope to be able to undertake an international nuclear industrial placement, possibly at ITU or the University of Nevada.
- The opportunity to present my work to the public.

Progress:

- Since starting in October 2015, I have synthesised and characterised the cement blends that are relevant to encapsulation of plutonium contaminated waste.
- XRD and SEM analysis have been used to identify key phases within these samples, allowing me to relate to the literature and the theory of cement formation and hydration products.
- From January 2016 onwards, non-active batch sorption studies will be carried out on individual cement phases, with a view to moving onto plutonium sorption studies later on in my PhD.



Modelling the Surface Chemistry of PuO₂ at the Molecular Level

DR. BENGT TEGNER
PDRA, UCL

Wish List:

- I would like to understand the interactions of water with the actinide dioxides in detail, especially the role of defects.
- Be able to explain the most likely reasons for the gas build-up in the PuO₂ interim storage cans.
- Be able to extract relevant parameters that can be measured experimentally, such as desorption temperatures.
- Be able to advise on best practice when preparing PuO₂ for long-term storage to minimise the risk of pressurisation.

Progress:

- Compared molecular and dissociative adsorption of water on the UO₂ (111) and PuO₂ (111) surfaces and compared with earlier results on ceria.
- Presented a poster at the 9th International Conference on the f-elements in Oxford on the 6 - 9th of September 2015.
- Presented a poster at the half-day symposium "Studying Surfaces: In Vacuo, In Situ, in Silico" at the RSC in London on the 22nd of January 2016.
- Will give an oral presentation at the 2016 Waste Management Conference in Phoenix, Arizona, USA.



Glass Composite Materials for Sellafield LP&S ILW Immobilisation

CHARLES HUTCHISON
PhD Student, Imperial College London

Wish List:

- Complete results section of PhD thesis documenting the characterisation and corrosion study of eight GCM's received from Sellafield.
- Use literature alongside these results to compare and contrast expected corrosion behaviour with actual behaviour.
- Compare samples produced with similar composition but treated using different thermal techniques (Plasma furnace versus joule heated ceramic melter).
- Use the results to better characterise the samples; crystalline materials with a large amount of substitution have resulted in "fuzzy" XRD data making them difficult to fully identify.
- Publish papers regarding these samples.
- Get a job after PhD submission.

Progress:

- All experimental work has been completed.
- First three chapters of the thesis has been completed and reviewed, ideally more corrections are needed.
- The majority of the results section has been completed.





Grain Boundary Damage Mechanisms in Strained AGR Cladding Under

Irradiation

CHIARA BARCELLINI
PhD Student, University of Manchester

Wish List:

- Access to a facility for the preparation and the characterisation of slightly radioactive samples.
- Sample stage for irradiation able to handle high temperatures (higher than 450°C).
- Access to more un-irradiated AGR cladding stainless steel.

Progress:

- Irradiated a 20Cr25Ni Nb-stabilised sample with a 3MeV proton beam at 350°C using the DCF pelletron (3.6dpa reached at the Bragg pick 0.6dpa elsewhere).
- Intensive training with SEM and TEM.
- Preliminary characterisation of un-irradiated samples with SEM and EBSD.
- Attended to the MATRAC 1 Summer School.
- Attended to the NNL course "An Introduction to Nuclear Industry".
- Attended to the Haysham Nuclear Power Plant visit organised by NDA (Focus Group on Spent Fuels and Nuclear Materials).



Modelling Hydrogen Generation from Radioactive Sludges

CONRAD JOHNSTON
PhD Student, Queens University Belfast (Associated Partner)

Wish List:

- Information about the temperatures within the magnox sludge. Is there a 'typical' sludge temperature, or is there localised heating around fragments of fission products?
- Data about thermal conductivity of the sludge.
- Data about the activity of sludge samples.

Progress:

- Produced an extended solid state model of brucite mineral, one of the common components of Magnox sludge.
- Currently examining the effect of adding electronic defects (excess electrons and electron holes, which are a consequence of irradiation) to this solid.
- Preparing a molecular dynamics model of the sludge, prior to adding electronic defects once more. This allows for the effects of thermal motion on these electronic defects to be seen at representative temperatures.
- Preparing a methodology for using molecular dynamics to explore thermodynamically feasible chemical reaction pathways within the sludge model.



Modelling of Sludge Mobilisation and Transport

DR. DERRICK NJOBUNWU
PDRA, University of Leeds

Wish List:

- More computing power (processors and memory).
- Embark on a short term scientific visit (STSV) to Prof Alfredo Soldati of University of Udine, Italy, and Prof Michael Breuer of Helmut-Schmidt-Universität Hamburg, Germany. The STSV will foster collaboration, to learn a new technique.

Progress:

- Completed writing, debugging and test-running of the CFD code to handle particle-particle interactions in turbulent channel flows.
- Large eddy simulation to predict turbulent flow, Lagrangian particle tracking with enhanced hard-sphere collision model and van der Waals interactions to predict particle-particle interactions, and particle break-up due to turbulent shear stress.
- Results of sensitivity of turbulence intensity, gravity and particle sizes on collision frequency, collision efficiency and shear break-up of agglomerates is in progress.
- Modification of the developed CFD code to handle particle-particle interactions in turbulent pipe flows relevant to the nuclear industry is on-going.





Glass Composite Materials for Fukushima ILW Immobilisation

DIMITRI PLETSEK
PhD Student, Imperial College London

Wish List:

- In-canister vitrification equipment, canister and furnace facilities.
- Access to spent adsorbents from HP-ALPS.
- Active work at Hitachi Research Laboratories in Hitachi City, Japan.

Progress:

- Two glass compositions (lead borosilicate (PBS) glass and lead borate (PB) glass) suited to accommodating model adsorbent in glass composite material (GCM) wasteform at maximum processing temperature of 600°C.
- PBS GCM pressureless sintered wasteforms produced, 40 wt.% waste loading achieved.
- PB GCM pressureless sintered wasteforms produced, foamed microstructure but full encapsulation achieved up to 30 wt.% waste loading.
- Microstructure of final product finely tuned by controlling composition, sintering and thermal treatment regimes.



Understanding the Interfacial Interactions of PuO₂ with Water

DR. DOMINIC LAVENTINE
PDRA, Lancaster University

Wish List:

- Characterisation of the cross-sections of the lanthanide and actinide oxide layers by FIB-SEM and TEM (currently being installed as part of NNUF).
- Classified worker training to allow use of plutonium and analytical facilities at NNL.

Progress:

- Ceria coated QCM crystals have been further characterised by XRF, confirming the thickness of the layer, and by cyclic voltammetry, showing the layers to be impermeable.
- Urania (U₃O₈) layers have been synthesised by precipitation from oxalate and nitrate solutions and their thickness and surface morphology characterised by microbalance and SEM. Work is continuing on the synthesis of UO₂ and thoria, (ThO₂) layers under reducing conditions.
- Temperature-response dependence studies of the ceria and urania coated crystal transducers have been undertaken (up to 300°C).
- The absorption/desorption of H₂O onto/from ceria-coated crystal transducers up to 350°C has been measured.



The Behaviour of Used Nuclear Fuel in Wet Storage

ELIZABETH HOWETT
PhD Researcher, Lancaster University

Wish List:

To complete Sellafield training and start experiments there in the coming year.

Progress:

Simple electrochemical techniques have been used to analyse the corrosion behaviour of simulated AGR steel cladding samples under a range of interim spent fuel storage pond conditions. Samples were studied at a range of pond water temperatures (room temperature, 45°C (normal pond operating temperature), 60°C (peak pond operating temperature) and 90°C (pond temperature under a partial loss of coolant condition)), pH and chloride concentration. Initial findings indicate that, compared to a baseline condition of 24°C and existing typical pond pH of 11.4, there is no localised corrosion threat to AGR fuel cladding as the pond water/electrolyte temperature is increased from 24°C to 90°C. This assumes that the fuel has not undergone stress corrosion cracking or intergranular attack before submersion in the ponds and these conditions are currently in the process of being investigated.





The Interaction of Brucite Surfaces with Uranium and its Fission Products

ESZTER MAKKOS
PhD Researcher, University College
London

Wish List:

- Experimental results related to the adsorption of Sr^{2+} , Cs^{2+} and UO_2^{2+} onto brucite (comparison of ions, structural data, any kind of energy related result).
- Contact with other researchers who are working on similar projects or doing quantum chemical calculations in this area.

Progress:

- Optimised the computational parameters of the brucite model by studying the adsorption of a series of s block ions onto brucite with the previously developed embedded cluster model.
- Proved the reliability of the embedded cluster model, comparing the results with another, different method (periodic DFT).
- Improved the brucite model by introducing a monolayer and double layer of water onto the surface.
- Started to investigate the adsorption of Sr^{2+} complexes onto hydrated brucite surface.



Novel Ion Exchange Materials

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

Wish List:

- Design and build of a rotating hydrothermal reactor for the synthesis of hierarchical microporous ion exchangers.
- Active tests on newly developed ion exchangers.
- Workshops or training courses on computer simulations of hydrated microporous zeolites.
- Hot isostatic pressing to produce ceramic wastefoms for investigation
- Focused ion beam sample preparation of ceramic specimens for transmission electron microscopy.

Progress:

- Current work has focused on the modification of the crystallographic and electrostatic environment in Sn-umbite ($\text{K}_2\text{SnSi}_3\text{O}_9 \cdot \text{H}_2\text{O}$) by varying the ratio or species of substitution in the framework. Different isomorphously substituted Sn-umbites were hydrothermally prepared, structures studied via Rietveld refinement and ion exchange properties tested to prove guidance for optimisation of the materials.
- Fitting of atomistic potentials for computer modelling studies of tin silicate systems is ongoing.
- Attempts have also been made to synthesise hierarchically micro-meso porous structured zeolites for flow continuous ion exchange process. Hierarchical monoliths or spheres are advantageous due to the better accessibility of reactants to the active sites and the ease of recycle and reuse.



Novel Ceramic Wastefoms for Cs and Sr Encapsulation

GEORGE DAY
PhD Researcher, University of
Birmingham

Wish List:

- Transmission electron microscopy (TEM) studies in order to identify discrete ceramic phases in hot isostatically pressed (HIPed) ion exchange materials.
- Further studies of HIP products formed under varied conditions.

Progress:

- Explored new routes to Ba doped caesium ceramics waste forms.
- Early stage TEM/EDS analysis of the ceramic products formed from HIPed spent ion exchangers.
- Analysis of synchrotron x-ray data on HIPed Cs/Sr wastefoms.
- Novel atomic potentials derived in order to assess the thermodynamic stability of Cs ceramic wastefoms after transmutation to Ba.





Production of Real-time Segmented as-Built CAD Models

HENRY CHENG ZHAO
PhD Researcher, University of Birmingham

Wish List:

My research project is RoMaNS. I hope that I can know more detailed information about the robot arm and the real industry manipulation environment. It will be good if I can contact with some robot arm manipulation engineers in nuclear industry.

Progress:

Demonstrate 3D SLAM and 3D reconstruction for robot arm manipulation only using one Kinect camera instead mechanical odometry based on graph optimization. Many visual features tests using different features like SIFT, SURF, ORB and BRIEF are performed. Also many graph optimization tests like G2O, TORO and GTSAM are performed. All the corresponding 3D point map and camera path data are saved. A detailed report about those had been completed.



Modelling of Sludge Mobilisation and Transport

DR. HUGH RICE
PDRA, University of Leeds

Wish List:

- Information on and kilogram-scale samples of most suitable test materials from industrial team members would be very useful.
- In particular, some examples of site-specific flow rates and composition of more complex slurries encountered on nuclear sites, e.g. SPP1 and HALES.
- A review of diagnostic equipment currently used for in-line flow and materials characterisation would be of interest.

Progress:

- Two pipe flow loops commissioned at the University of Leeds;
- One equipped with acoustic and pressure transducers to investigate in-line rheological behaviour and critical deposition velocities of nuclear-analogue suspensions in both vertical and horizontal flow regimes at several pipe diameters using Doppler velocimetry and pressure drop;
- The other equipped with an optical system (particle image velocimetry) for the study of suspensions in horizontal flow including high-precision, near-wall measurements;
- Three materials to be tested in first instance: barium sulphate, calcium carbonate and magnesium hydroxide at concentrations up to several tens of percent by volume;
- Experimental work to be completed February-March 2016.



An Investigation of Wasteform Evolution During Wet-recovery and Drying of SNF

DR. JAMES DARNBROUGH
PDRA, University of Bristol

Wish List:

- Reliable access to a 4 circle single crystal standard XRD equipment for high resolution XRD and XRR measurements.
- Access to an XPS capable of taking hot samples.

Progress:

- Purchased required equipment for construction of 3 Omega thermal conductivity measurement equipment.
- Produced samples for; conducted beamtime on and started analysis of in-situ hydridation of epitaxial thin film of uranium.
- Awarded oral presentation for work at Journee des Actinides 2016.
- Awarded PDRA money to conduct mimic fission daughter product ion implantation into uranium dioxide thin films for characterisation and then dissolution experiments.
- Worked in support of Sophie Rennie during other synchrotron experiments and sample preparation.





Investigation of Anomalous Hydrogen Production from Water Adsorbed on Oxides

JAMIE SOUTHWORTH
PhD Student, University of Manchester

Wish List:

- Autosampler to increase the volume of samples able to be analysed.
- Access to XPS for surface analysis.

Progress:

- Initial ZnO data collected and analysed.
- Vacuum line built and testing begun.
- Mass spec attached to high vacuum chamber.
- TPD experiments for the low energy electron irradiation of ice begun.



The Interaction of Water with PuO₂ Surfaces

JOSEPH WELLINGTON
PhD Student, University College London

Wish List:

- Experimental data on which surface terminations are most prevalent in UO₂ and PuO₂, particularly in stored PuO₂ powder.
- Experimental data of adsorption/desorption energies on UO₂ and PuO₂ surfaces.

Progress:

- Adsorption energies for water on UO₂ and PuO₂ (111) and (110) surfaces have been refined with the counterpoise correction.
- Adsorption energies and geometries have been calculated for water adsorbing in the second layer on the UO₂ and PuO₂ (110) surfaces.
- Oxygen 1s binding energies have been calculated on the (111) and (110) surfaces of UO₂ and PuO₂ without water and when water has molecularly or dissociatively adsorbed.



Development of Raman Spectroscopy Techniques for Remote Analysis

KATE WYNESS
PhD Student, University of Bristol

Wish List:

- Through the guidance of Sellafield - finish off the first prototype of a remote Raman probe for the use of underwater Raman analysis.
- Ensure the Raman Probe is suitable for a wet radioactive environment and is build robust enough to survive time underwater and high levels of radiation.
- Perform corrosion work on NNL Samples.
- Build library of Raman Spectra from NNL samples.
- Test run of newly developed probe in an aqueous environment.

Progress:

- Built Test ROV.
- Visited Sellafield.
- Started initial trials of Remote Raman Probe, using laboratory space tested distance up to 3m.
- Established link with Manchester/NNI for collaboration on algae samples.
- Underwater light trials, tested for absorption theory vs practice.
- Visited, Germany Karlsruhe for summer school on actinide science and its applications.
- Visited Sludge and slurry team (Sellafield group).
- Equipment set up. Acquired suitable spectrometer and LASER wavelength. Optical bench used to test set up before being miniaturised into a portal probe.





Enhanced Shear Micro- and Ultra- filtration Without Recycle Pumping

KEITH SCHOU
PhD Student, Loughborough
University

Wish List:

- A validated model of cake formation under enhanced shear
- A validated model of application of shear (axial, azimuthal / fluid etc.)
- System developed to handle ferric floc at concentrations used in industry, under enhanced shear conditions
- A robust (maintenance free) system for creating enhanced shear with minimal alterations to currently used ultrafiltration equipment in the EARP.

Progress:

- Tested of azimuthal and axial oscillation as forms of creating shear.
- Tested surface and depth filters under enhanced shear.
- Tested the effect of shear on cake size (thickness & weight).
- Tested the effect of shear on cake packing.
- Tested the effect of shear on particle retention.
- Presented work at 2 conferences, 1 site visit, 1 promotional/competition video, planned to at 2 more conferences.
- Observed enhanced shear filter cake removal.
- Observed striations in cake, which only occur in enhanced shear systems.
- Working towards a paper.
- Developed testing techniques to be used with Ferric floc filtration.
- Development of a comparison between particle retention, flux and shear.



An Investigation of Wasteform Evolution During Wet-recovery and Drying of SNF

DR. LEILA COSTELLE
PDRA, University of Bristol

Wish List:

- Access to an annealing furnace, up to 1700 °C.
- Access to a potentiostat with high temperature measurement capabilities.
- Access to a high resolution 4 circle XRD.

Progress:

- Design and characterization of U and UO₂ microelectrodes.
- DISTINCTIVE – ARF award to design a portable sample storage device (UHV and inert gas compatible) for transfer between ‘nuclearised’ instruments across the UK.
- Abstract accepted for a poster presentation at Journee des Actinides 2016.
- High resolution XPS study conducted on beamline I09, Diamond Light Source, in Sept 2015, in support of Sophie Rennie.



Thermal Treatment of PCM and ILW

LUKE BOAST
PhD Researcher, University of Sheffield

Wish List:

I start a student placement with Kurion in Sellafield on the 8th of February, and from that placement I hope to be involved with industrial scale active glass melts which I can then use to form a chapter of my thesis.

Progress:

- 6 weeks of dissolution data which aims to understand the product stability with respect to generic ILW disposal concepts. The experiment will run for the duration of my PhD (12 months)
- I start a student placement for 3 months with Kurion in Sellafield to assist with their current work schedule. I will use the results obtained from the placement for my thesis.





Understanding the Interfacial Interactions of Plutonium Dioxide with Water

DR. LUKE JONES
PDRA, University of Manchester

Wish List:

- Access to alpha active facilities including laboratories and gloveboxes.
- Access to active materials, in particular PuO_2 .
- Equipment able to handle alpha materials to study surface effects (e.g. SEM/XPS).

Progress:

- Regular discussions with industrial representatives and supervisors.
- Developing technologies to undertake active research including design of bespoke reaction vessels and bespoke sampling/analysis techniques.
- Progressing through Sellafield and NNL site training to undertake research utilising active materials and facilities.
- Follow up research from postgraduate project, of relevance to this work including inactive trials using external radiation sources.



In-situ Ground Contaminant Containment

DR MATTEO PEDROTTI &
CHRISTOPHER WONG
PDRA & PhD Student, University of Strathclyde

Wish List:

- We are currently happy with our level of industrial engagement on our work package (Physical barriers for in-situ contaminant containment). We are currently collaborating with Sellafield Ltd., NNL, BAM Ritchies and BGS.

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.
- Currently investigating the consolidation behaviour of the colloidal silica grout.
- Currently investigating silica grout-radionuclide interactions, with a focus on the impact on radionuclide mobility via sorption/desorption experimental tests.



Irradiated Sludges

MEL O'LEARY
PhD Researcher, Queens University Belfast (Associated Partner)

Wish List:

- Financial Support for the development of the new irradiator £25000-£50000 for the additional parts to construct of 1-2 of these irradiators – we have many of the parts as legacy from previous research projects.
- Input on stimulants for sludges, particularly Magnox sludges
The chemical makeup of sludges
Materials that mimic the chemical properties of sludges
Processes of interest occurring in sludges of industry relevance

Progress:

- Sample Chamber for Sludgy Samples constructed.
- Gas sampling system for sample chamber developed.
Samples the headspace of the sample chamber.
Headspace then flowed through a gas chromatograph .
- Design for a new high dose rate irradiator.
Predicted to produce dose rates of upto 100 Gy/s when built.
Uses low energy gammas (10-20 keV).
Gammas will enter sample from every direction.





Gas Retention and Release from Nuclear Legacy Waste

MICHAEL JOHNSON
PhD Student, University of Leeds

Wish List:

A comprehensive understanding of the structure of two-phase sediment, prior to gas generation, is crucial for developing models to explain the mechanisms for bubble growth within the bed. I would like to use micro-CT to characterise the size and connectivity of the pore network in magnesium hydroxide sediments of different concentrations. Since the micro-CT at the University of Leeds is out of commission, it would be of great benefit to use the Skyscan system at the National Nuclear Laboratory for this investigation.

Progress:

Rheological characterisation of magnesium hydroxide soft sediments has been performed using the vane method and further oscillatory rheology is planned using a plate-plate geometry. Laboratory scale gas retention tests using decomposition of hydrogen peroxide for gas generation have revealed yield stress regimes vulnerable to potential *rollover events* where a high voidage bulk sediment becomes less dense than water. X-ray CT tests have been performed for magnesium hydroxide soft sediments across a 7-234 Pa shear yield stress range. This has enabled quantitative analysis of the retained bubble population as it evolves with time.



Computational Modelling of PuO₂ Ageing and Fuel Residues

NATHAN PALMER
PhD Student, University of Birmingham

Wish List:

- Visit(s) to the Sellafield Site or to National Nuclear Laboratory (NNL) would be useful to further knowledge of Theme Two.
- Collaboration with other researchers (especially computational based) in Theme Two could be useful to extend learning.
- Access to codes for modelling relevant phenomena e.g. defect chemistry, empirical fitting for deriving interatomic potentials, radiation damage etc. would be useful.
- Training in modelling techniques e.g. molecular dynamics or in coding e.g. Fortran or software e.g. Matlab would be appreciated.
- If any Universities run courses on defect chemistry, behaviour of actinide fuels etc. it would be useful to be involved.

Progress:

- Reading of the literature for research purposes and for writing up of first year Literature Review.
- Training using GULP program through computer workshops and use outside these.
- Use of GULP program applying it to UO₂ and PuO₂ to investigate various properties.
- DISTINCTIVE Theme meeting at University of Lancaster in November 2015, networking with other researchers.
- These properties include the interatomic potentials by various authors to investigate temperature dependence of material properties (lattice parameter, macroscopic moduli, dielectric constants etc.)
- Use of GULP to calculate point defect formation energies, bound defect formation energies for PuO₂ using various published potentials.



Computational Simulations of Storage Pond Sludge Disturbance

OLIVIA LYNES
PhD Student, Lancaster University

Wish List:

- Basis sets and pseudopotentials for actinides for use with CP2K.
- Working computational model of brucite for use with CP2K.
- Speciation data of the Sellafield Storage ponds.
- pH variation and control data of the Sellafield storage ponds.

Progress:

- Completed *ab initio* molecular dynamics calculations for a single magnesium, calcium and strontium ion in a system containing 64 water molecules of water with CP2K.
- Explored the effects of increasing temperature on the above ion, water systems.
- Completed *ab initio* molecular dynamics calculations for hydrated hydroxide structures of magnesium, calcium and strontium.
- Explored the effects of increasing temperature variation of the hydrated structures.





Autonomous Systems for Nuclear Decommissioning

OLUSOLA AYOOLA
PhD Student, University of Manchester

Wish List:

- Access to any particle size analyser that works on the principle of Ultrasonic Spectroscopy will be appreciated.
- MHz acoustic transducers for temporary usage will be most appreciated.

Progress:

- Simulation of spatial uncertainties associated with sludge sampling.
- Development of confidence maps for Particle Size Distribution predictions.
- Assessment of sampling factors and their impact on uncertainty.
- Simulation and experimental validation of analytical uncertainties associated with particle size analysis techniques (in progress).
- Design of an in-situ sludge sampler and particle size analyser (in progress).



New Ion Exchange Materials For Effluent Clean-up

RYAN GEORGE
PhD Student, University of Birmingham

Wish List:

- Synchrotron X-ray powder diffraction data for structure studies on doped Zr-Si-Umbite systems to correlate with ion exchange properties.
- Ion exchange studies with active solutions at realistic conditions for tests of ion exchange competition and kinetics.

Progress:

- Successfully synthesised a pure germanium form of Zr-Si-Umbite.
- Successfully scaled up the synthesis of Zr-Ge-Umbite with the hope of performing a range of ion exchange experiments.
- Synthesised a range of doped Zr-Si-Umbites, focusing on partial germanium doping.
- Synthesised and ion exchanged a layered zirconogermanate material.



Ceramic Materials for Actinide Disposition

DR. SHI-KUAN SUN
PDRA, University of Sheffield

Wish List:

- Access to NNL for the investigation of Pu doped Synroc.
- Access to Diamond for the Neutron Diffraction and Residual Stress (Strain Mapping).
- Access to Ion Accelerator for the irradiation.

Progress:

- Attended The Ninth International Conference on High-Performance Ceramics (CICC-9) in Guilin, China and gave an invited talk on 'CaUTi₂O₇ Ceramics for Actinide Disposition'. Finished a manuscript ready for submission.
- Performed formulation optimisation on synthesis of Ce pyrochlore, quantification phase analysis regarding the phase diagram, determination of Ce oxidation state by X-ray Absorption Spectroscopy and structural refinement by Neutron Diffraction.
- Performed irradiation on the zirconolite glass ceramics, which were provided by NNL; some characterisation works of the pristine and irradiated samples has been done using GIXRD, AFM and Raman, etc. The measurement of residue stress is ongoing, in order to explain the origin of the microcracking.





UO₂ Surface Reactivity and Alteration

SOPHIE RENNIE
PhD Student, University of Bristol

Wish List:

- Access to high resolution 4 circle XRD.
- Access to a radioactive monochromated XPS.
- Support for understanding the chemistry of water radiolysis, and how it may be possible to experimentally test this in conjunction with previous XRD studies.

Progress:

- Successful growth of epitaxial U3O8 thin films.
- High resolution XPS study conducted on beamline I09, Diamond Light Source, Sept 2015. Experimental data is currently being analysed in collaboration with Dr David Morgan, Cardiff University.
- Xe and Ce implantation of UO₂ thin films has been planned with the Surrey Ion Beam Centre. Samples will be used to investigate the impact of fission products on UO₂ dissolution. This forms a continuation of previous work (DOI: 10.1039/c4fd00254g), and is scheduled to take place I07, Diamond Light Source in Feb 2016.
- Abstract accepted for an oral presentation at JdA 2016.



Understanding Surface Species and Interactions Between Adsorbed Chloride and Water on Stored PuO₂

SOPHIE SUTHERLAND-HARPER
University of Manchester

Wish List:

- Contaminate CeO₂ (various particle surface areas) with a range of relative humidities and Cl- concentrations from both vapour (HCl solution) and gas.
- Heat treat samples at a range of temperatures and determine how much of each species has come off and in what phase.
- Apply for Active User Lab (KIT-ITU) to synthesise Cl-contaminated CeO₂, ThO₂ and UO₂ thin films and analyse with XPS and TPD
- Write GENTLE proposal to carry out analyses at KIT-ITU on PuO₂ once it has been shipped from Sellafield-NNL (~6 months). Also conduct experiments at NNL on aged Magnox, fresh and annealed PuO₂; XRD, SEM-EDS, TEM, XPS, IC, IR, BET and TGA.
- Get trained at NNL for handling Pu.
- Publish 2 papers (on NNL's samples and my samples).

Progress:

- Presented poster at NGN Winter school.
- Presentation for DISTINCTIVE PuO₂ themed meeting.
- Gamma and alpha irradiation experiments at DCF.
- Visited ITU and NNL and will start working in laboratories in due course after writing a proposal.
- Started training at Sellafield for Pu handling.
- Training on XPS analysis, SEM-EDS and BET.
- Used Ion Chromatography for leaching experiments.
- Synthesised batches of CeO₂.
- Writing first paper on NNL's samples.



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

STEPHANIE THORNBER
PhD Researcher, University of Sheffield

Wish List:

- Stephanie is currently making modifications to the Hot Isostatic press (HIP) facility at the University of Sheffield so she can process active (U/Th) samples. This will make it the only active research scale HIP in the UK. To do this successfully new equipment is required to ensure health and safety standards are met and efficient retrieval and analysis of samples can take place.
- Stephanie is also hoping to take a research placement at ANSTO to further excel her innovative research with Pu-containing HIP samples. Stephanie is currently in the process of applying for funding towards her placement research costs.

Progress:

- An optimised formulation has been achieved such that current experiments are investigating waste incorporation with Ce as a Pu analogue and the effect of mineralisers and additives on waste digestion.
- Stephanie gave an oral presentation at the 2015 MRS conference in Montpellier, France. Her proceeding paper has been submitted and accepted.





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

Remediation

TOM MULLAN
PhD Student, University of Strathclyde

Wish List:

- Project is still in early stages and, as such, we do not yet have any specific requests for outside engagement or collaborations.

Progress:

- Literature review of biomineralisation processes, use of phosphate minerals in permeable reactive barriers, microbially induced phosphate precipitation utilising organic phosphate substrates, and the potential to use phytate as a phosphate donor.
- Choice made of microorganisms to use in initial experiments.
- Initial experiments will assess ability of microorganisms to hydrolyse phytate and the factors influencing this process.
- Analysis will cover free phosphate released to solution, degradation products of phytate, and substances (e.g. organic acids) secreted by microorganisms.
- These parameters will be used to predict and optimise conditions for mineral precipitation.

2ND ANNUAL MEETING



19TH – 20TH APRIL 2016

@Bristol and
ssGB
Bristol, UK

To Register:
<https://goo.gl/NJbsnl>



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Publications

The following peer-reviewed papers and articles 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 UO₂/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



Events

Annual Meeting - 2016

19th - 20th April 2016, Bristol
Registration for the 2nd Annual Meeting is now open! The conference will be held @Bristol, and the evening dinner on the ssGB. Contributions will be made by all DISTINCTIVE researchers, and representatives from industry. To register, visit: <https://goo.gl/NJbsnl>

Media and Public Engagement Summer School

22nd - 24th June 2016, Sheffield
Each DISTINCTIVE researcher is invited to attend the Creativity@Home workshop that will be held at Halifax Hall, Sheffield. More information will be circulated by Dr. Claire Corkhill in due course.

Theme Meetings - 2016

One meeting will be held for each theme. The dates have yet to be confirmed but they will take place between September and November. Please check the DISTINCTIVE website for updates.



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