WP 5 Chemical Deuteration

Anna Leung, ESS

DEUNET Platform

- Benefit from **methods/expertise/manpower** at all facilities
- **Cost effective platform** to share materials
- **Include university, international and industrial partners**

Goals:

1. **User access** to existing products and services of the labs
2. **Development** of new methods and products
3. **Innovative materials** synthesized in collaboration between labs
4. **Coordinated access** for all European neutron users by 2019

Tasks

- **ISIS:** Chemical deuteration by catalytic H-D exchange and synthesis of surfactants
- **ILL:** Extraction and purification of molecules from deuterated cell cultures
- **FZJ:** Polymer synthesis
- **ESS:** Synthesis of complex deuterated molecules

Network coordination

Survey of European deuteration needs

Business plan to secure further funding by 2019

News and Updates

- Welcome to Krishna at ILL; thanks to Rachel Morrison (ILL) and Andreas Raba (FZJ)
- Hanna Wacklin-Knecht: 100% of her time is now dedicated to chemical deuteration at ESS
- Previous meetings:
  - WP5 meeting Grenoble January 2017
  - WP5 meeting/User meeting Oxford May 2017
  - WP5 meeting Lund March 2018
- Deuteration User Survey conducted 2017
- Several visits between facilities for training, discussion, planning
- Relationships formed with additional facilities with deuteration activities (J-PARC, SNS)
- First DEUNET newsletter produced by Alison Mader, ILL – to be circulated via neutron mailing list

WP5 Deliverables Overview

D	Name	Lead	Type	Diss	Month
5.1	Webpage and user portal	ESS	DEC	PU	9
5.2	Synthesis of precursors	STFC	R	CO	12
5.3	Novel route for isoprene synthesis	FZJ	R	PU	15
5.4	Synthesis of L- and D-lactic acid	ESS	DEM,R	PU	18
5.5	Synthesis of deuterated polythiophenes	FZJ	R	PU	20
5.6	Report on DEUNET requirements (workshop)	ESS	R	PU	24
5.7	Synthesis of surfactants for non-UK users	STFC	R, DEM	PU	28
5.8	Synthesis of deuterated polylactic acid	FZJ	R, DEM	PU	30
5.9	Optimisation of purification methods	ILL	R	PU	36 (42)
5.10	Physico-chemical characterisation	ILL	R	PU	42
5.11	Synthesis of deuterated lipids/surfactants	ESS	R	PU	42
5.12	Platform management, operation and access	ESS	R	PU	48

ISIS

- **Task 5.1: Chemical deuteration by catalytic H-D exchange and synthesis of surfactants**

- recruitment of post doc Kun Ma completed

- precursors for surfactants, lipids and polymers synthezised (D5.2) completed:

- **supplied precursors to ILL for their synthesis;**
- **Suppliedprecursors to ESS for their synthesis.**

- deuterated synthesis performed for non-UK users (D5.7) completed:

1. **The facility has supported Professor P Santini (PI, Università di Parma, Italy), for his project on Spin dynamics of the Mn12 prototype nanomagnet fully unravelled by 4-dimensional inelastic neutrons scattering, which needed a large amount of perdeuterated ligands for the target compound synthesis.**
2. **The facility has supported non-UK users by synthesis of deuterated surfactants, for example, routine deuteration of CTAB, SDS , AOT and nonionic surfactants(C12E6) to Andrew Jackson (ESS, Lund University) for their project on Applying self-assembly in deep eutectic solvents to templated ionothermal synthesis in a joint Ph. D project with Professor Karen Edler (University of Bath).**
3. **The facility has supported the synthesis of non-routine compounds to non-UK users, eg. Deuterated Oleic Triglyceride, Tween 80 surfactant, etc. (Tommy Nylander from Lund University)**
4. **The facility has supported Mr F D M del Monte, CSIC, Instituto de Ciencia de Materiales de Madrid, SPAIN , who needed a large amount of deuterated resorcinol , deuterated urea and deuterated choline chloride on the study of deep eutectic solvent dilutions: nanometer size domains and molecular reorganization.**
5. **Supported Professor Adrian Rennie'S experiment with the title "The effect of an applied electric field on the adsorption and desorption of surfactants" (RB 1710365) on the SURF, ISIS (Uppsala University, Sweden). This work will develop an understanding of the influence of applied fields and allow means to control modification of interfaces that will be of wide importance in many applications. The ISIS Deuteration facility has supported deuterated cationic surfactants as requested.**

ISIS

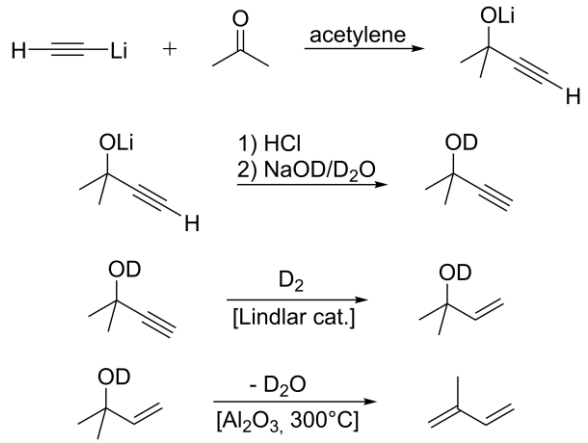
6. Supported Knaapila Professor M deuterated solvents for the experiment “SANS study of the synthesis of interpenetrating polymer networks in supercritical CO2”(RB1710239) on SANS2D, ISIS (Technical University of Denmark).
7. Hosted and supported the PhD student Marek Schomber from Georg-August-University of Goettingen (supervisor: Prof. Dr. Götz Eckold, Institut for Physical Chemistry) to synthesis deuterated PEA for his PhD project on copper and manganese single crystal compounds. The ISIS Deuteration Facility provided Marek access to the lab and equipment along with the training in reiteration methods.
8. Supported Dr D Perinelli’s experiment with the title “Investigation on the air-water adsorption behaviour of N-acyl amino acid surfactants” (RB 1720311) on the SURF, ISIS (University of Camerino, ITALY) to understand the different behaviours of the analysed N-decanoyl amino acid as regards cytotoxicity and membrane interaction. The ISIS Deuteration Facility has supported 10g of deuterated decanoic acid for the experiment.
9. Supported Mr F del Monte’s experiment with the title “Study of the reorganization of DES upon dilution with Benzylalcohol” (RB1720237) on the NIMROD, ISIS(CSIC, Instituto de Ciencia de Materiales de Madrid) to understand the differences found when mixing a DES with BA or W. The ISIS Deuteration Facility has supported deuterated benzyl alcohol, resorcinol, urea and choline chloride for the experiment.
10. Supported Dr J Sotres’ experiment with the title” Surfactant Modified Salivary Pellicles” (RB1720420) on the INTER, ISIS (Malmo University, SWEDEN) to study how surfactants of different ionic character interact with salivary films and influence their hydration and, therefore, their protection of oral mucosa. The ISIS Deuteration Facility has support deuterated surfactants: SDS, C12E5 and DTAB as requested.
11. Supported Professor Adrian Rennie’s experiment “Investigation of PVC plasticizers on phospholipid monolayers”(RB 1810574) on the SURF, ISIS (Uppsala University, Sweden). The ISIS Deuteration Facility has supported deuterated 2-ethylhexyl alcohol as a precursor for the synthesis.

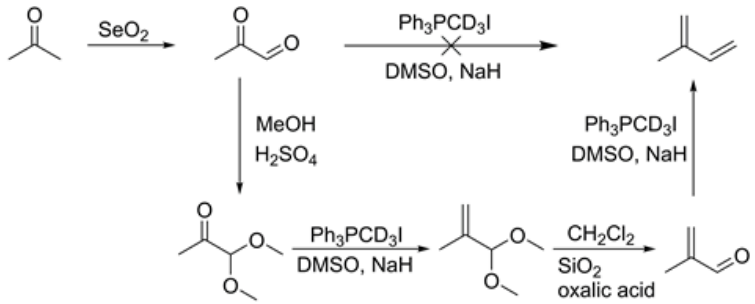
ISIS

The other activities:

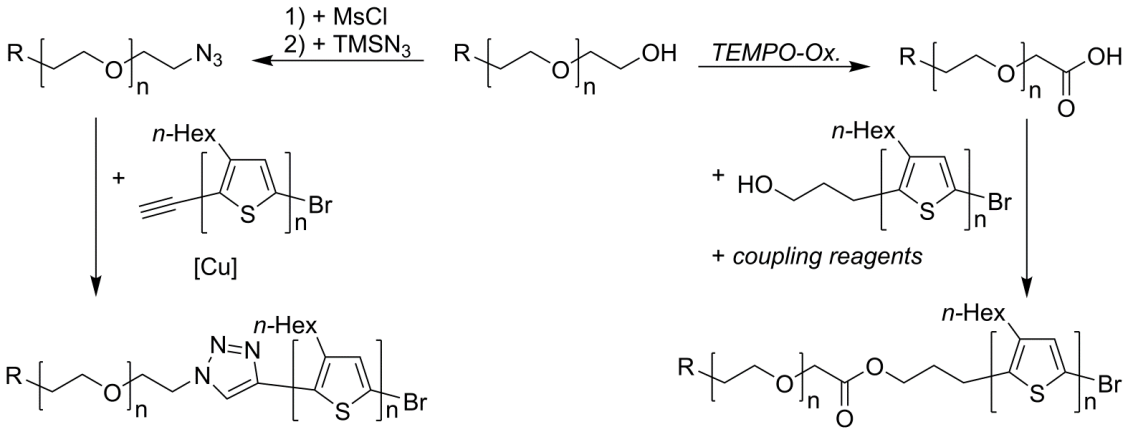
1. Dr Kun Ma has successfully synthesized a series of deuterated compounds for the ISIS user program: deuterated long chain primary alcohol (C26, C28); cationic surfactants, such as TAB and with the various counterions, e.g. Cl, NO3, SO4 etc.; anoinic surfactants: SDS and DS with various counterions, e.g. NH4, Li, etc. ; C16D33SiCl3, C14D29SiCl3, C12D25SiCl3, C18D37SiCl3; Chain deuterated short peptides and a few carbonated betaine surfactant.
2. Dr Kun Ma has produced deuterated fatty acids with various chain lengths, e.g. C4, C8, C12, C16, C18 and has reduced some of them to bromoalkanes, alcohols to build up deuterated starting blocks.
3. Hosted and Organised WP5 kick off meeting at ISIS 27th November in conjunction with STFC Deuteration facility workshop, 2015
4. Attended WP5 meeting at AGM in Coimbra, 2016
5. Attended WP5 meeting at ILL 18-19 January 2017
6. Hosted and organised STFC User meeting with WP5 User workshop May 2017 in Oxford
7. Attended WP5 meeting at ESS 5th March 2018

- **D5.3 Novel route for isoprene synthesis**





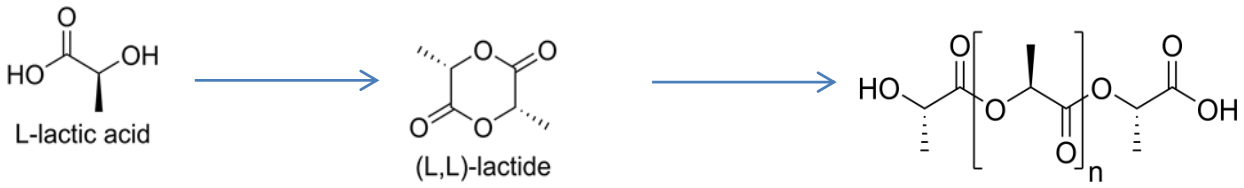
- **D5.5 Synthesis of deuterated polythiophenes**



partially deuterated P3HT-PEO diblocks synthesized

FZJ

- **D5.8 Synthesis of deuterated polylactic acid**



ESS JCNS RWTH deuterated polylactide synthesized

- **Publications:**
  - M. Staropoli, A. Raba, C. H. Hovelmann, M.-S. Appavou, J. Allgaier, M. Krutyeva, W. Pyckhout-Hintzen, A. Wischnewski, and D. Richter, Melt dynamics of supramolecular comb polymers: Viscoelastic and dielectric response. Journal of Rheology 61, 1185 (2017)
  - K. Ciepluch, A. Radulescu, I. Hoffmann, A. Raba, J. Allgaier, D. Richter and R. Biehl, Influence of PEGylation on domain dynamics of phosphoglycerate kinase: PEG acts like entropic spring for the protein. Bioconjugate Chemistry, accepted for publication.

ILL

- Cell cultures grown in perdeuterated media: tried acetobactor and P. Pastoris – decision to continue working with P. Pastoris
- Optimisation of lipid extraction protocols

- Developing purification methods for lipids
- Investigate the effect of fatty acid feed on resulting phospholipid production.
- Acquisition of Gas Chromatography set-up
- Staff: post-docs R. Morrison (07/2016 – 04/2018); K. Batchu (06/18 – 12/19)
- Investigate routes for large scale production and availability for users.

- Publications:

Characterization with neutron scattering: structure of hydrogenous and deuterated multibilayers by small angle diffraction (Luchini et al. Coll. & Surf. B, 2018)

Floating bilayers from natural lipids(Kiesel et al., *under revision*)

ESS

- D5.1 Webpage and user portal
- D5.4 Synthesis of D- and L-lactic acid-d_4 (manuscript in preparation)
- D5.6 Report on DEUNET requirements, workshop
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5.1 Deuteration.net

DEUNET

Secure | https://deuteration.net

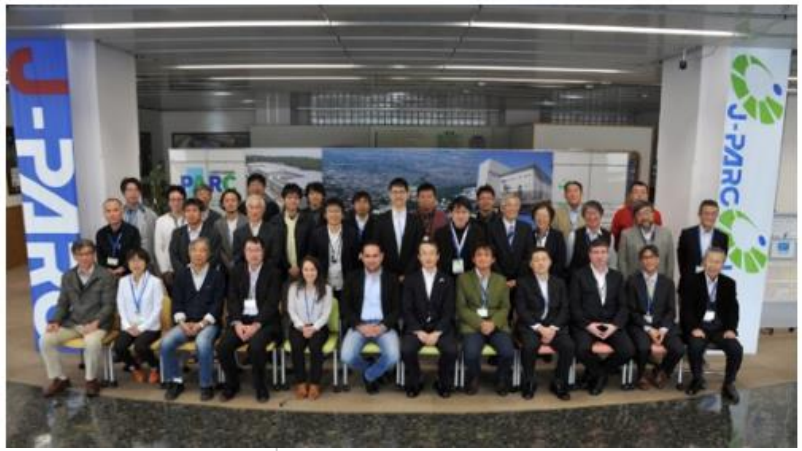
My Site | Reader

More for Less: Low-Cost, High-Yield

J-PARC Deuterated Materials Workshop

November 1, 2017 annaleung1

J-PARC (Japan Proton Accelerator Research Complex) last month held a workshop entitled "Deuterated Materials Enhancing Neutron Science for Structure Function Applications", at the Ibaraki Quantum Beam Research Centre, Tokai, Japan. There were over 60 participants in the workshop, which was held over two days. J-PARC have recently established on-site laboratories dedicated to chemical and biological deuteration and the aim of the workshop was to discuss how to activate deuteration science at J-PARC.



Enzyme Cata Catalysed Sy

March 13, 2018 annaleung

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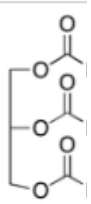

Scheme 1. Lipase-catalysed hydrolysis/formation of esters.

d the European ach to high-yield llography.

sciences require n crystallography ins in sufficient in large (0.5 – 1.0 e 1). Our results terated proteins

ESS

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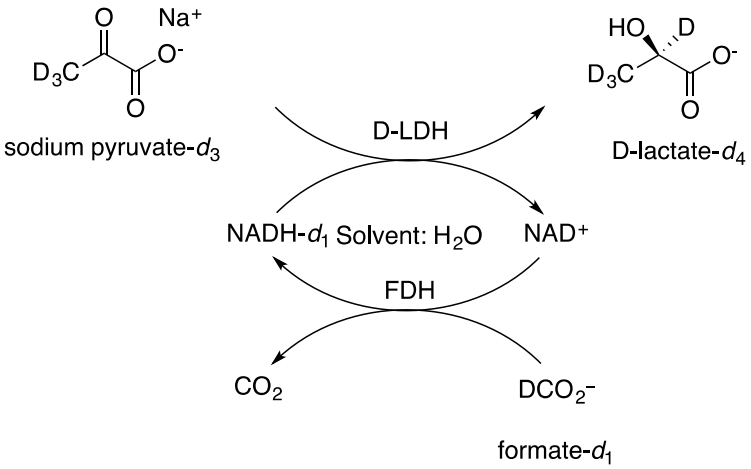
- **D5.4 Synthesis of D- and L-lactic acid-d_4 (manuscript in preparation)**



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- **5.12 Platform management, operation and access**

ESS

- **5.11: Masters Thesis project recently completed (with Lund University): Enzyme Immobilisation and Use in Deuterated Molecule Synthesis**
  - **Triglyceride/lipid modification using enzymatic catalysis**
  - **Work will be continued in the second half of 2018**