New Materials and Applications

Radiation & Radioactive Materials Research

UNLV | COLLEGE OF SCIENCES

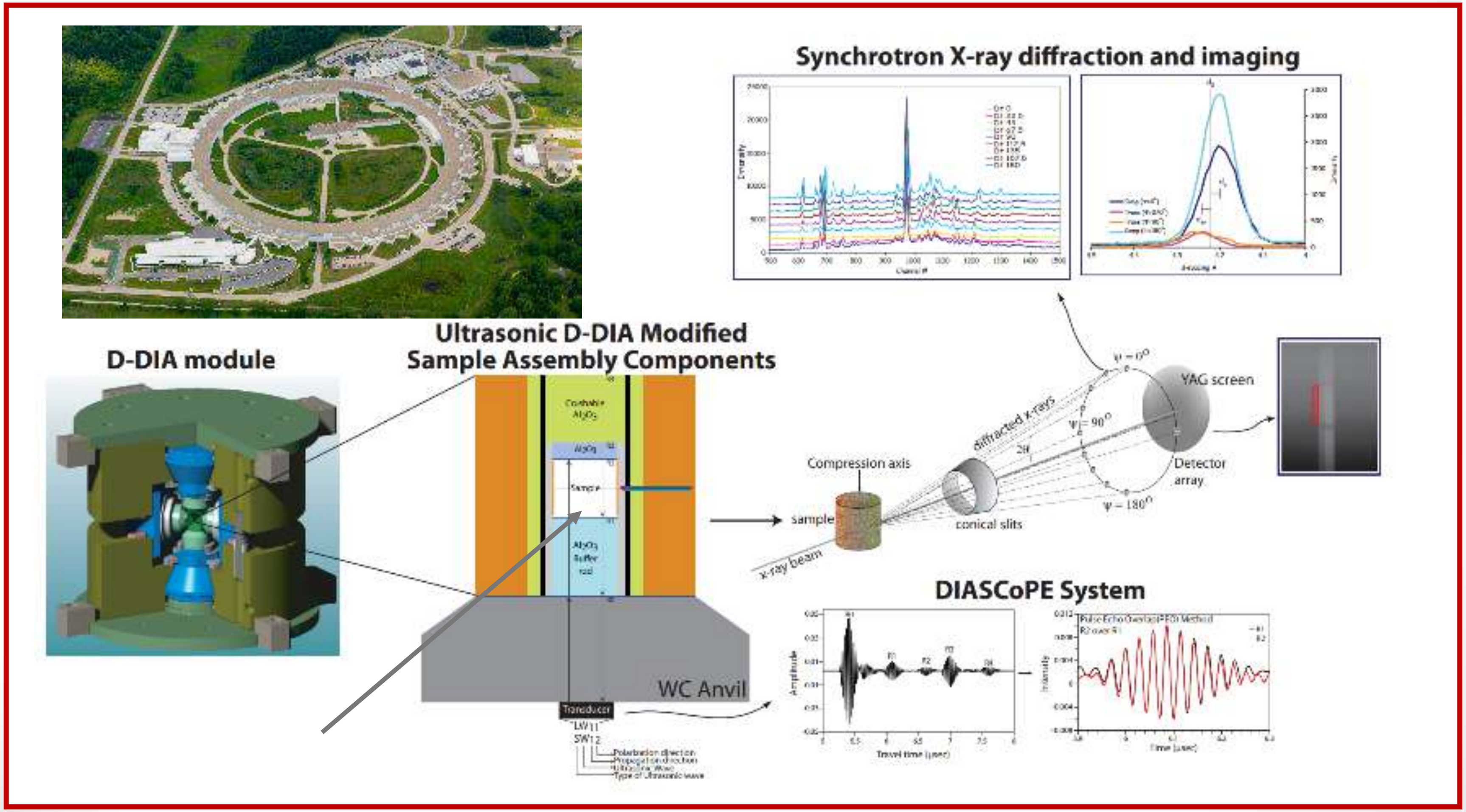
Materials Deformation

Dr. Pamela Burnley
Department of Geoscience
Phone: (702) 895-5460
Email: pamela.burnley@unlv.edu

Expertise

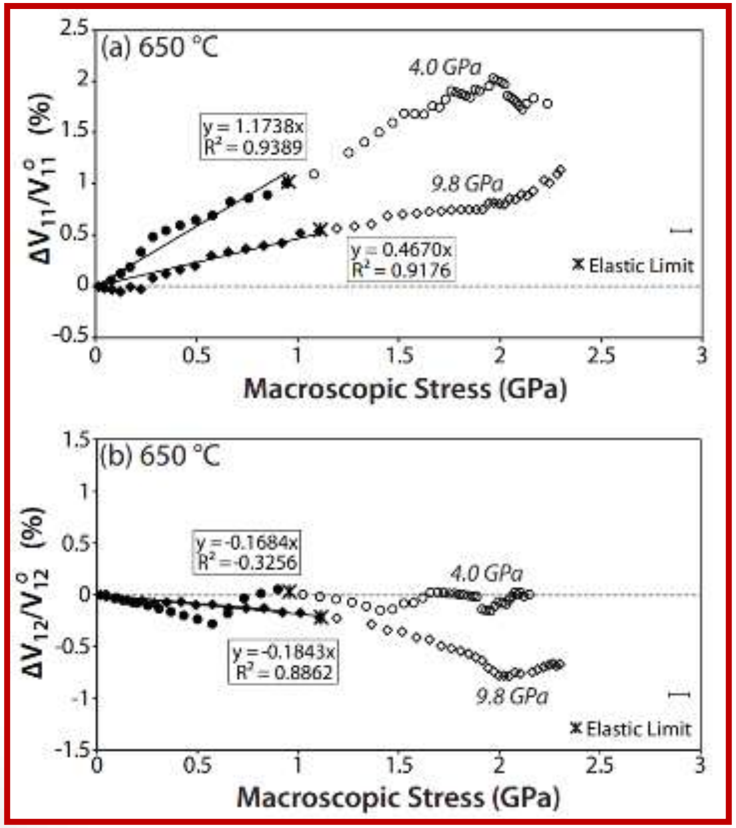
- High Pressure Rock Deformation

High Pressure studies of Deformation and the Acoustoelastic effect



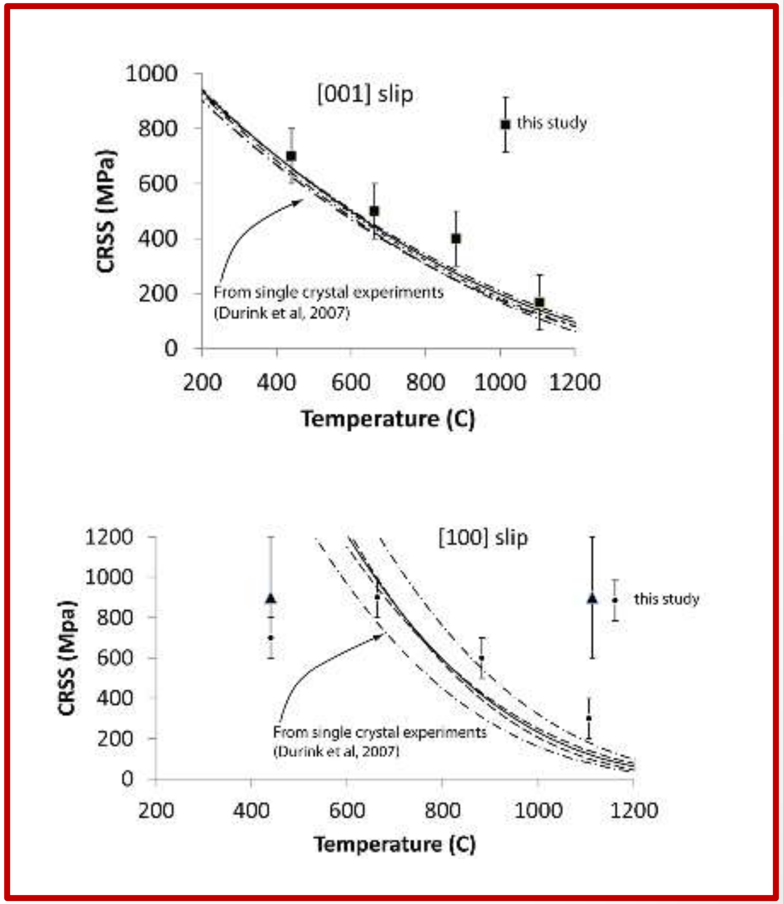
High Pressure studies of Deformation and the Acoustoelastic effect

Compression- and shear-wave velocities are a function of compressive stress



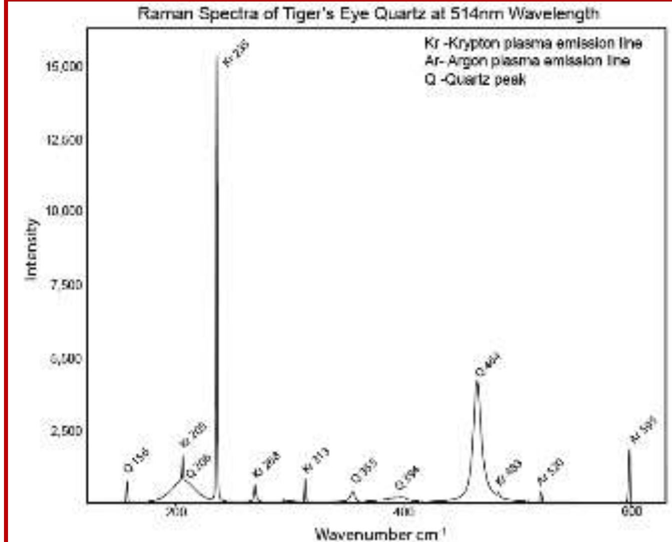
(Traylor, Whitaker & Burnley, in prep)

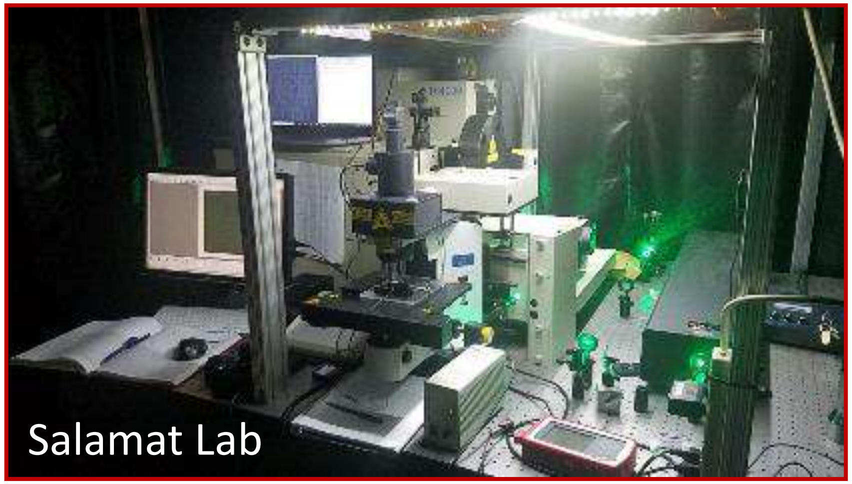
Details of multiple slip systems derived from a single multi step experiment

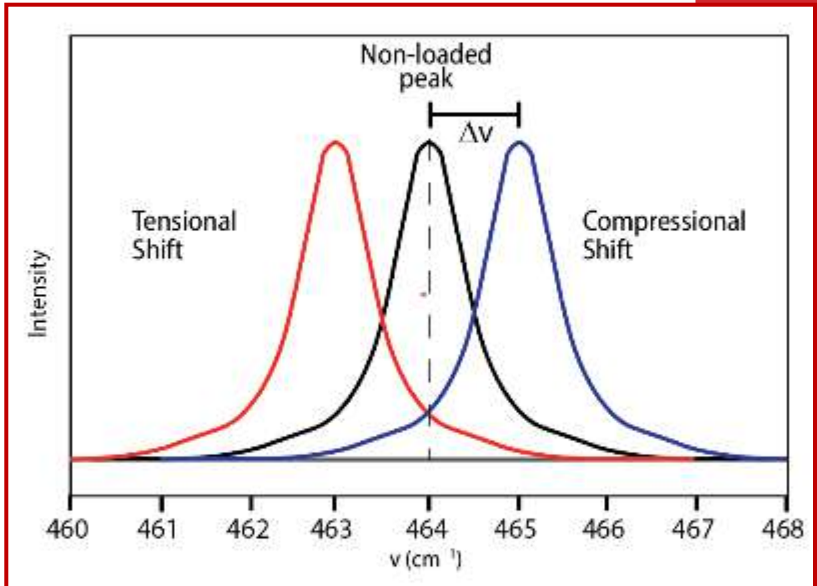


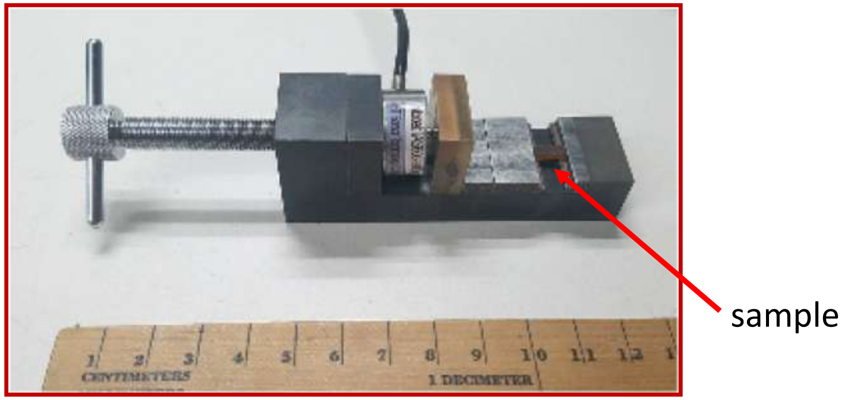
(Burnley & Kaboli, 2019)

Raman spectroscopic measurements of stress distribution





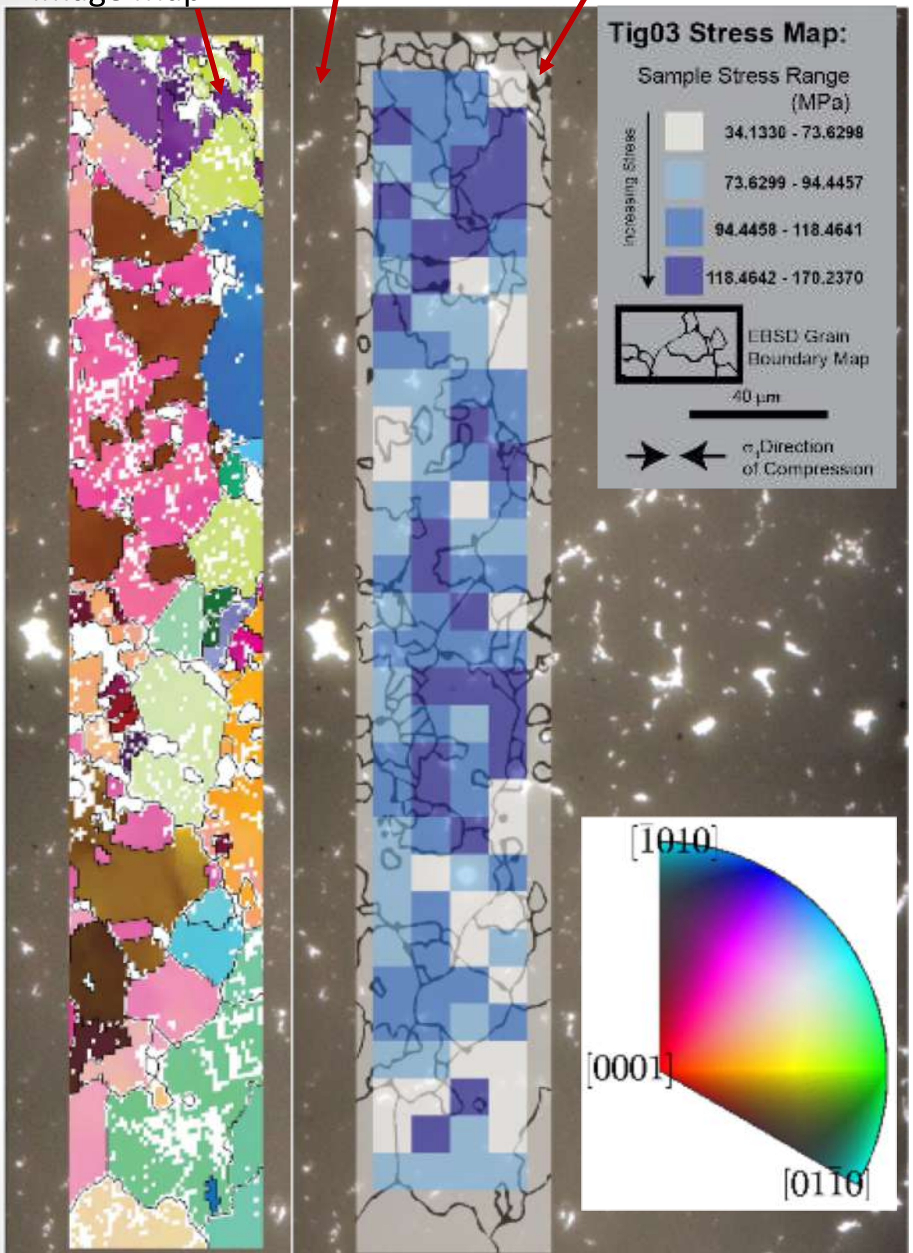


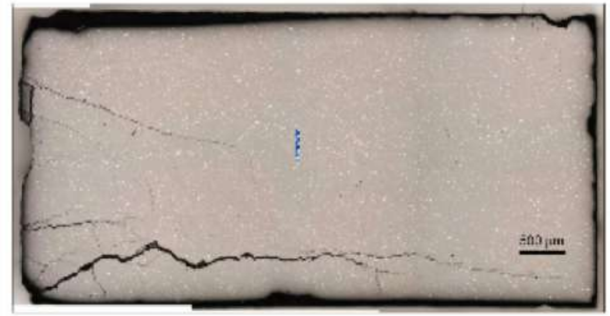


EBSD Orientation Image Map

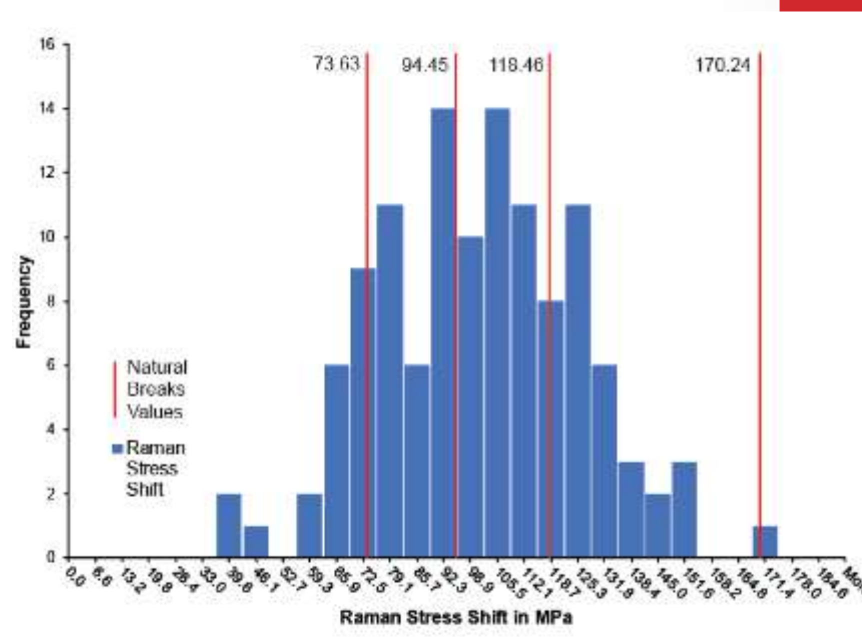
optical image

Stress map

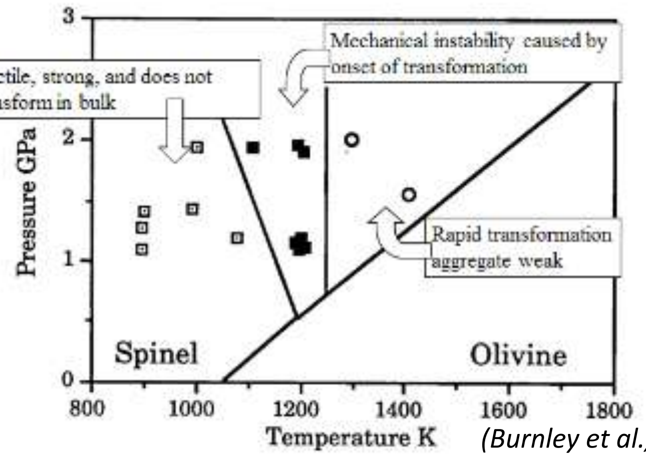




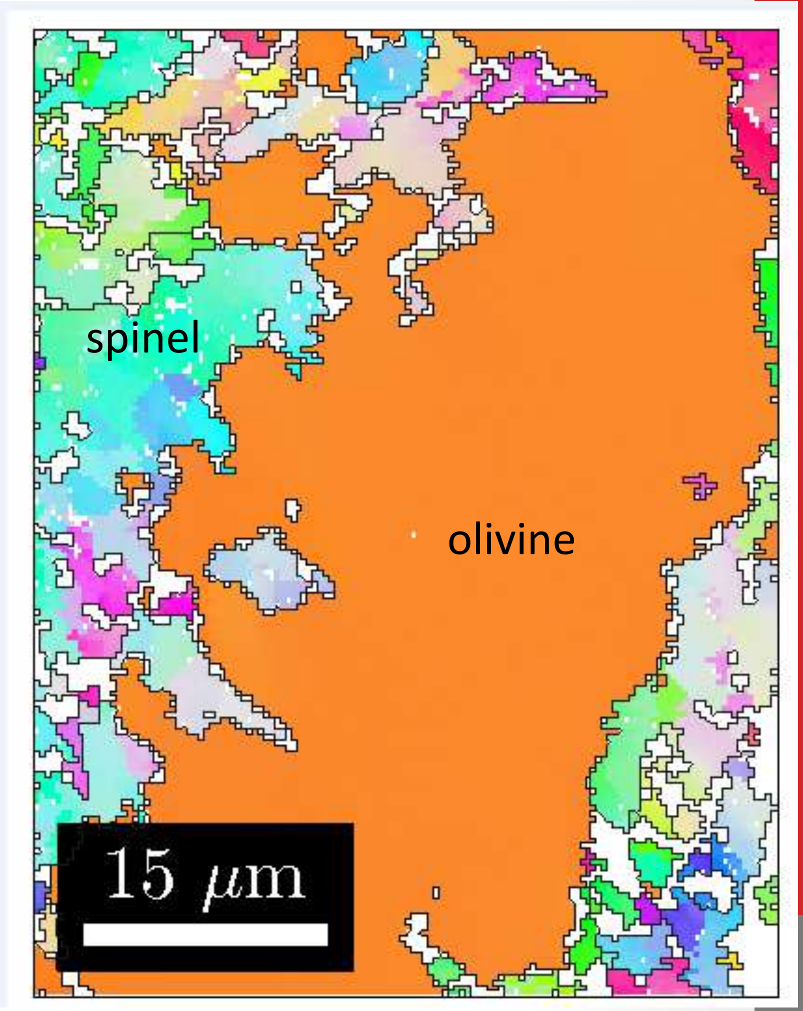
- Peak shifts converted to sample stress using single crystal measurements



Interaction of Phase Transformation and Deformation



(Burnley et al.,1990)



Electron Backscatter Diffraction Orientation Image Map

(Burnley et al., in prep)

- Growth of spinel in metastable olivine creates mechanical instability
- New microstructural analysis clarifies nature of instability

Radioactive Materials and Radiation

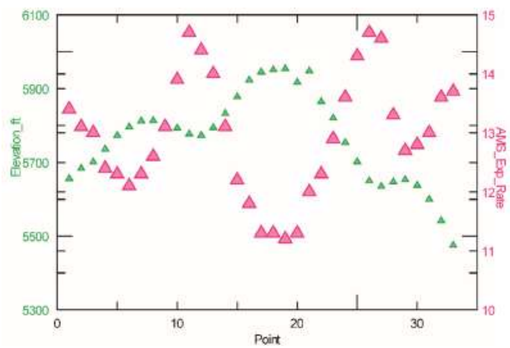
Dr. Pamela Burnley
Department of Geoscience
Phone: (702) 895-5460
Email: pamela.burnley@unlv.edu

Expertise:

Gamma ray background radiation

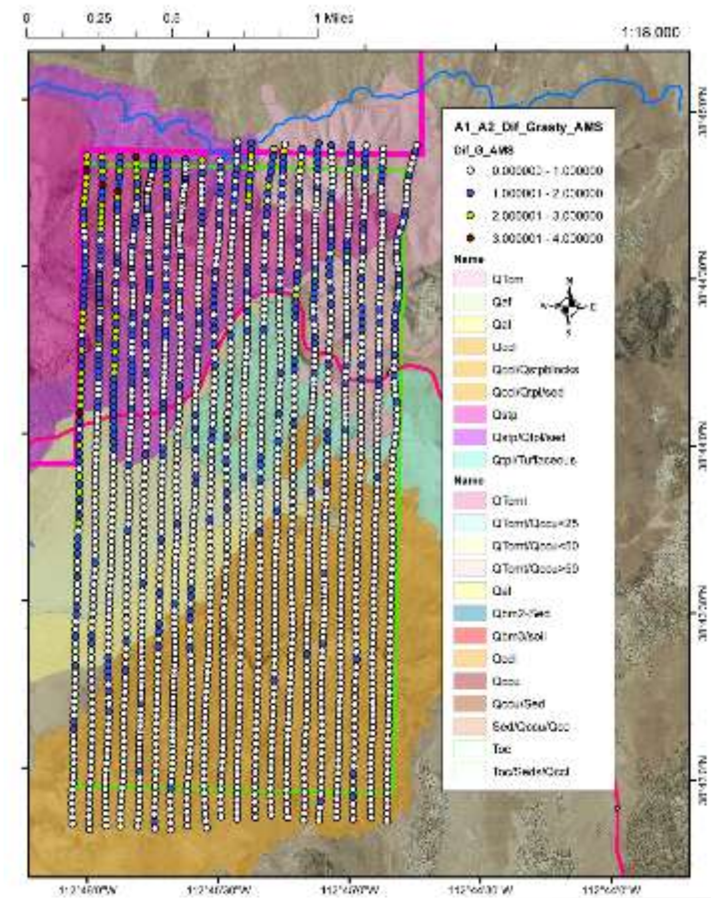
UNLV | COLLEGE OF SCIENCES

γ-ray Background Radiation



- Predictive model based on legacy NURE data & geologic map units
- Most points within 1μR/hr
- Largest deviations associated with steep topography
- Led to D. Haber's PhD research on topographic corrections

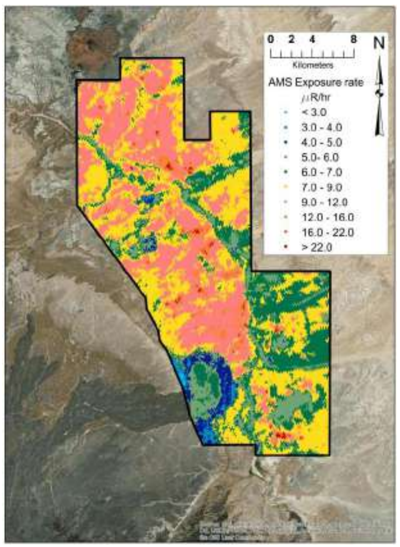
Difference between AMS flight data and predictive model



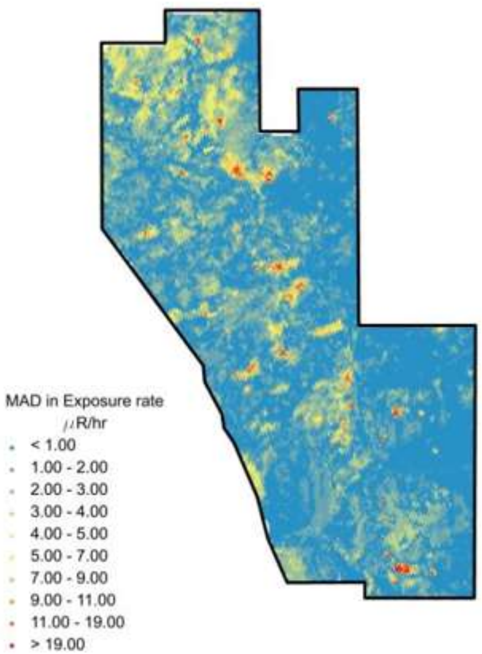
γ-ray Background Radiation

AMS flight data

Cameron, AZ

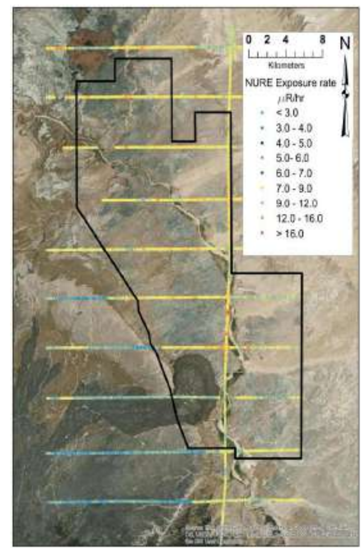


Difference between AMS data and model



Highlights Uranium mines

Model based on ASTER data, NURE survey & geologic map



(Adcock et al. 2019)

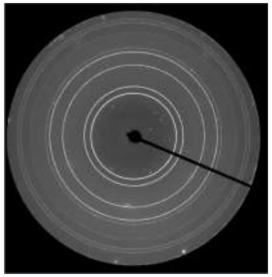
Radiochemistry

Paul M. Forster
Department of Chemistry and Biochemistry
Radiochemistry

UNLV | COLLEGE OF SCIENCES

Expertise:

-Structure determination (X-ray and neutron diffraction, total scattering)



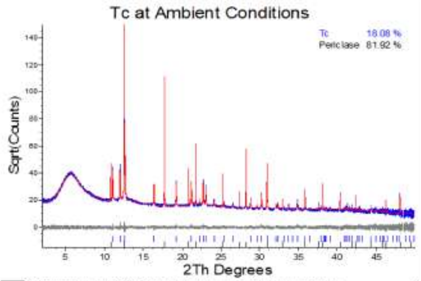
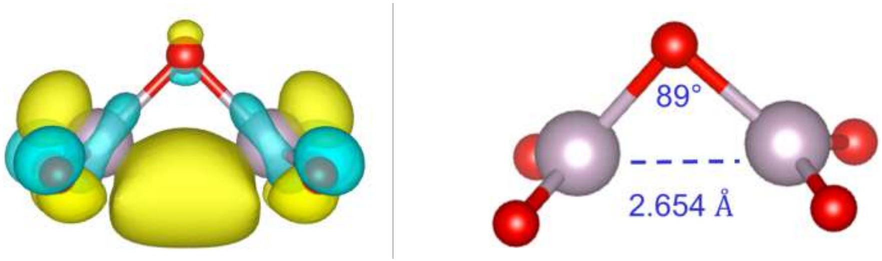


Figure 1 One-hour XRD of technetium metal and magnesium oxide.

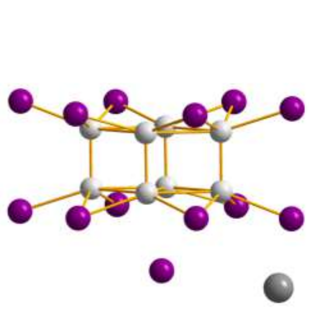
-Structure-property relationships, integrated simulation

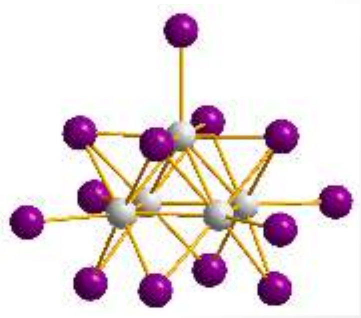


Probable identification of a gas phase technetium oxide molecule

-Hydro/solvothermal synthesis

Technetium iodide compounds prepared solvothermally



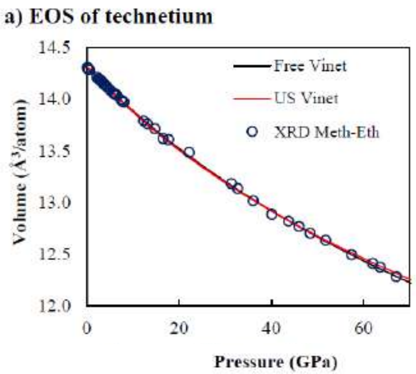


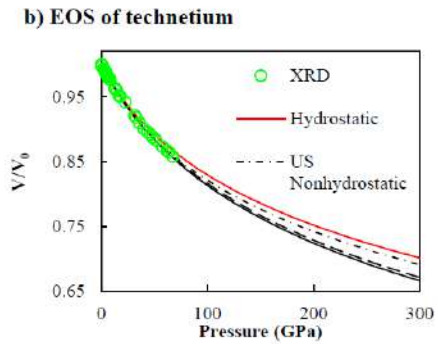
Paul M. Forster
Department of Chemistry and Biochemistry
Radiochemistry

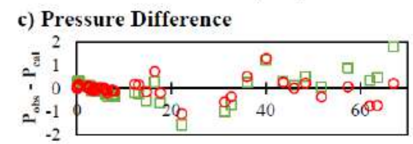
UNLV | COLLEGE OF SCIENCES

Relevant projects:

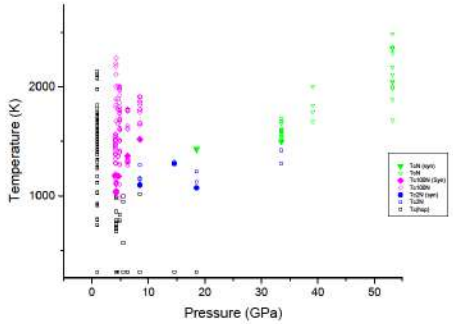
First diffraction-based equation of state for elemental Tc

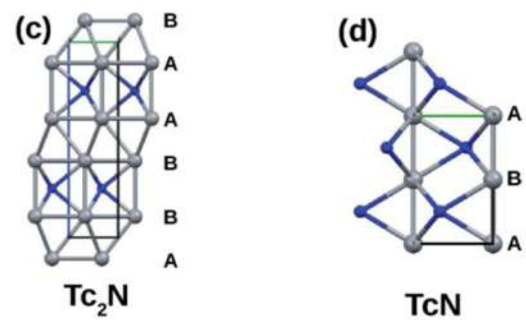






Discovery of new binary Tc nitrides





Paul M. Forster
Department of Chemistry and Biochemistry
Radiochemistry

UNLV | COLLEGE OF SCIENCES

Art Gelis

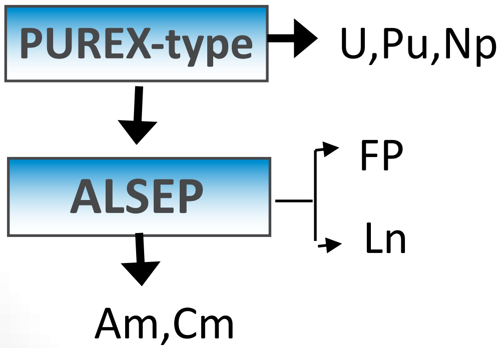
Director, Radiochemistry Program

Actinide Separations and Recovery

UNLV | COLLEGE OF SCIENCES

Design and Testing of Advanced Separation Processes using Additive Manufacturing

- **Liquid-Liquid Extraction and Separation of Plutonium, Uranium, Minor Actinides, Lanthanides and Fission Products**
- **Twenty-seven 3D-printed acrylic centrifugal contactors (CC), fabricated at Argonne National Lab are available at UNLV**
- **Contactors can be 3D-printed in stainless steel or any alloy**
- **Solvent extraction separations can be tailored to a specific goal**
- **Example: Actinide Lanthanide SEParation process - ALSEP, designed and tested for DOE-NE**

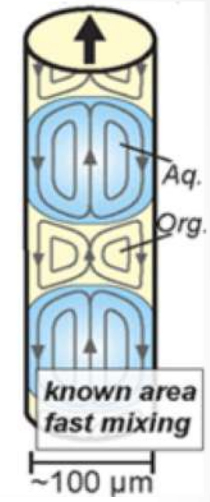


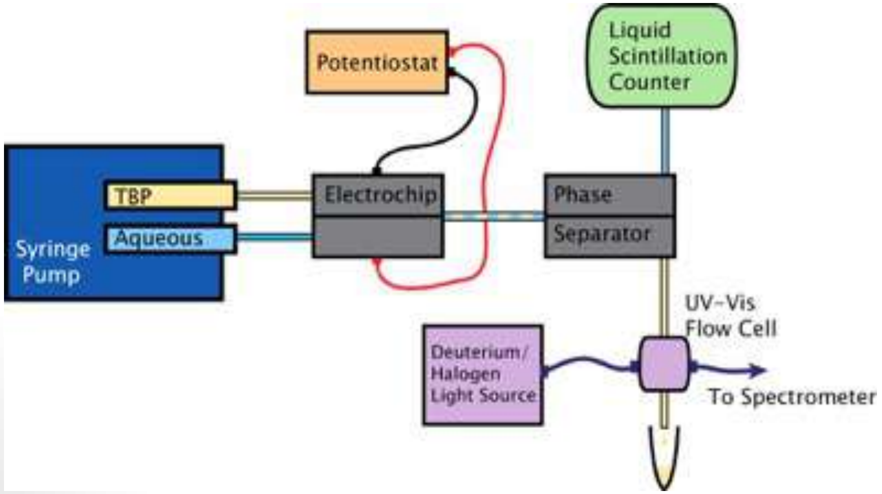
10+1 acrylic CC

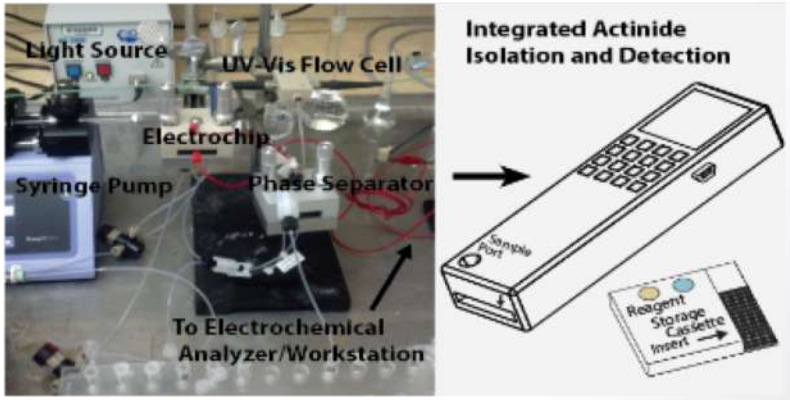
Steel CC

Microfluidic Systems for Rapid Radionuclide Separation and Detection

- **Microfluidic device to combine aqueous and organic phases, rapidly mix, then separate phases, following by analysis**
- **Selective Extraction of radionuclides on a very small scale**
- **Can be implemented either as a bench-top setup or as a portable detector**
- **Potential applications: rapid Pu separation and detection from Uranium and FP for safeguards; ”dirty bomb” analysis**







PUBLICATIONS

- Artem V Gelis, Peter Kozak, Andrew T Breshears, M Alex Brown, Cari Launiere, Emily L Campbell, Gabriel B Hall, Tatiana G Levitskaia, Vanessa E Holfeltz, Gregg J Lumetta *Closing the Nuclear Fuel Cycle with a Simplified Minor Actinide Lanthanide Separation Process (ALSEP) and Additive Manufacturing.* **Scientific Reports** volume 9, Article number: 12842 (2019)
- Kevin P. Nichols, Rebecca R. Pompano, Liang Li, Artem V. Gelis and Rustem F. Ismagilov Mechanistic Understanding of Nuclear Reprocessing Chemistries by Quantifying Lanthanide Solvent Extraction Kinetics via Microfluidics with Constant Interfacial Area and Rapid Mixing. *J. Am. Chem. Soc., 2011, 133 (39), 15721–15729*.
- Artem V. Gelis and Gregg J. Lumetta. Actinide Lanthanide Separation Process—ALSEP. Ind. Eng. Chem. Res., 2014, 53 (4), pp 1624–1631
- M. Alex Brown, Alena Paulenova, and Artem V. Gelis Aqueous Complexation of Thorium(IV), Uranium(IV), Neptunium(IV), Plutonium(III/IV), and Cerium(III/IV) with DTPA. *Inorg. Chem., 2012, 51 (14), 7741–7748*
- Gelis, A. V., Vandegrift, G. F., Bakel, A., Bowers, D. L., Hebden, A. S., Pereira, C., & Regalbuto, M. (2009). Extraction behaviour of actinides and lanthanides in TALSPEAK, TRUEX and NPEX processes of UREX+. *Radiochimica Acta*, *97*(4–5). https://doi.org/10.1524/ract.2009.1601
- Gelis, A.V., Pereira C, Nichols, K. Microfluidic process monitor for industrial solvent extraction system. US Patent # 9233859
- Gelis A.V. - Actinide and lanthanide separation process (**ALSEP**) US Patent 8,354,085, 2013

- More @google scholar profile   https://scholar.google.com/citations?user=0C7sSjMAAAAJ&hl=en

UNLV | COLLEGE OF SCIENCES

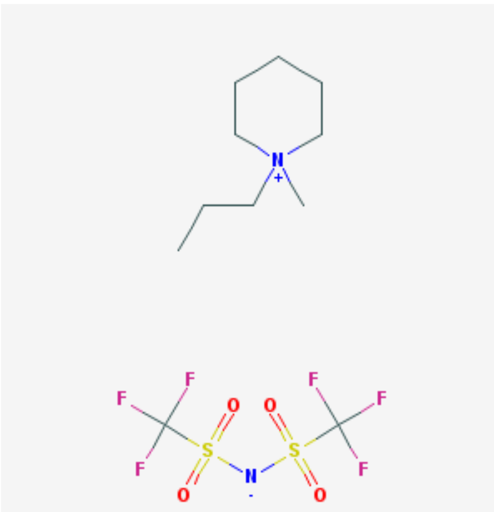
Strategic Materials Analysis and Recovery – David Hatchett and Ken Czerwinski

Dissolution of UF_6 into IL at 0 hours, 24 hours, 30 days, and the recovery of UF_6 salt.

Expertise:

- Actinide, Lanthanide, and Li materials recovery from Ionic Liquids (Ils).
- Electrochemical, Spectrocopic, and thermal analysis of Radioactive materials.
- Radiochemistry and Analytical Chemistry.

Strategic Materials Analysis and Recovery – David Hatchett and Ken Czerwinski



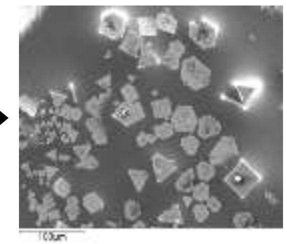
1-methyl-1-propyl piperidinium bis(trifluoromethylsulfonyl)imide [MPPi][TFSI]

$$UF_6 + 2\ TFSI^{-} \rightarrow UF_6^{2-} + 2\ TFSI\cdot$$

$[MPPi]_2[UF_6]$

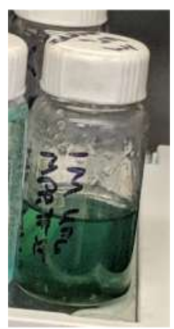
UF_6 salt

Electrochemistry



U metal Crystallites

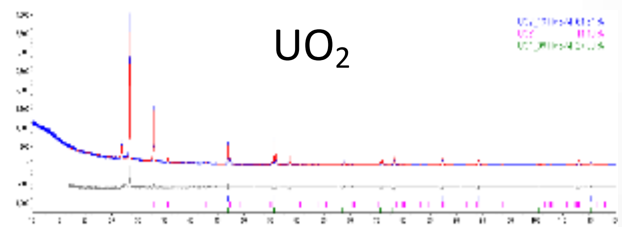
Low Concentration 0.1 M



High Concentration 0.95 M

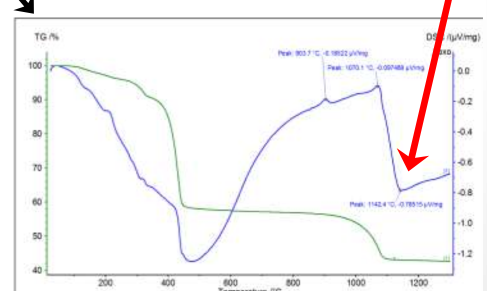
UF_6 salt

UO_2

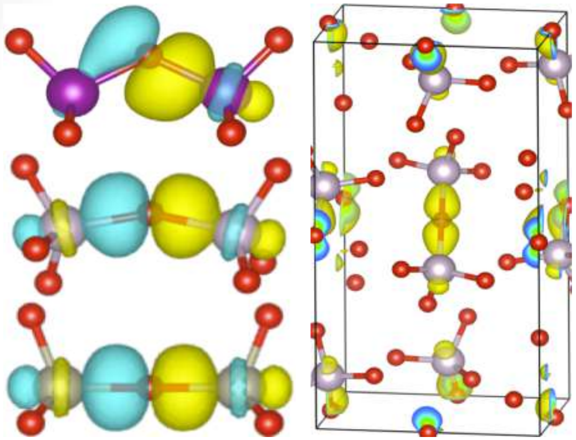


Air

U metal

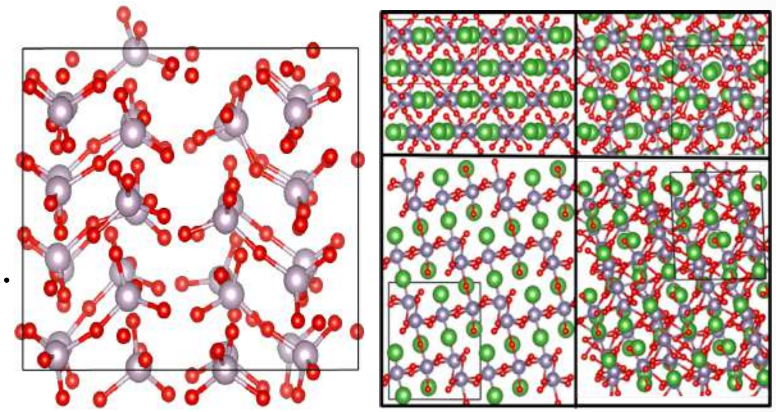


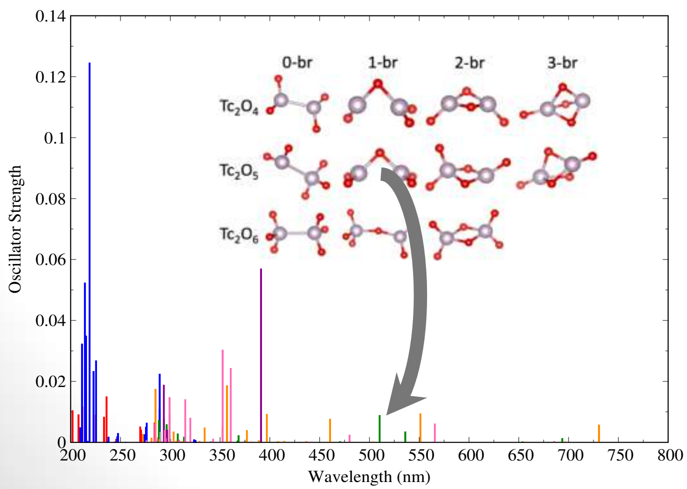
Paths to U recovery from UF_6 dissolved in IL



Electronic structure simulations of the bonding and properties of compounds synthesized by the team.

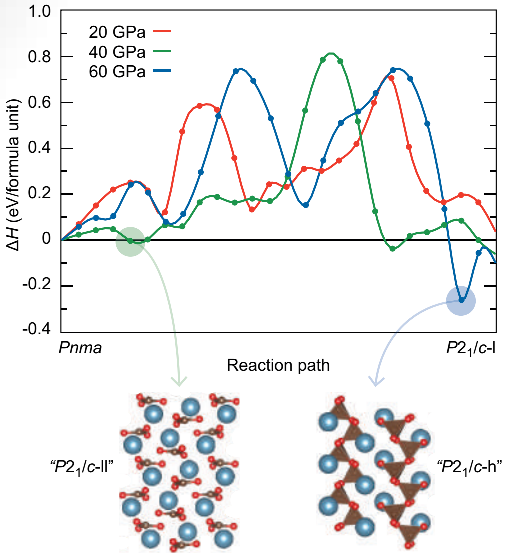
Molecular dynamics to understand the thermal behavior of materials and melts. *Supporting Salamat's high temperature experimental goals.



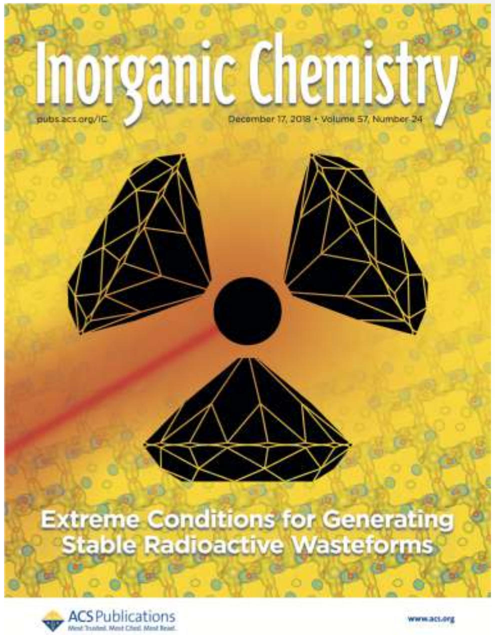


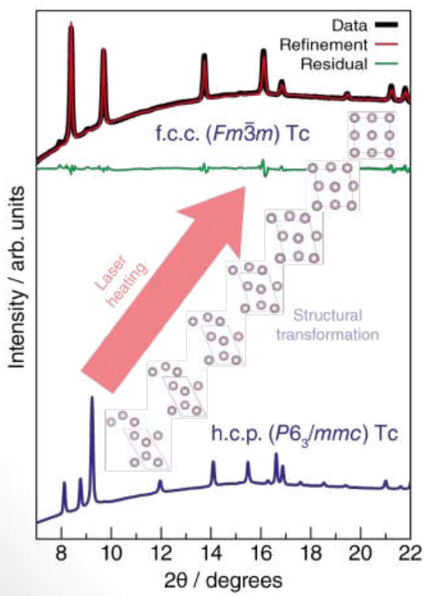
Automated molecular structure screening and simulated spectroscopy to understand speciation during reactions, ie. the reduction of TcO_4^- during vitrification.

UNLV | COLLEGE OF SCIENCES



Identifying new phases of materials and the transition pathways connecting them. Thus far targeting geological or wasteform problems.





Currently looking for new nitrides, sulfides and hydrides (especially of Tc) as well as developing reactive force fields for metals to expedite materials discovery by targeting both pressure and temperature conditions.

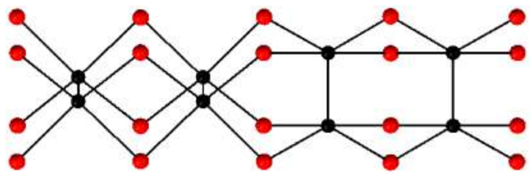
UNLV | COLLEGE OF SCIENCES

Technetium and Uranium Chemistry

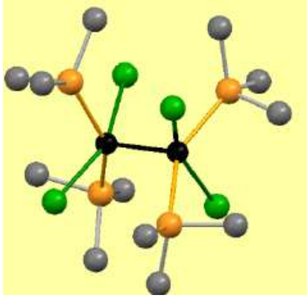
Frederic Poineau, Ph.D.
Radiochemistry

→ Synthetic and coordination chemistry

Technetium binary and ternary halide compounds
Compounds with multiple metal-metal bonds



$TcCl_2$: a unique structure-type



$Tc_2Cl_4(PMe_3)_4$

→ Chemistry relevant to remediation and fuel cycle applications

Separation, vitrification, and waste forms (alloys)

Demonstration of the separation of uranium from technetium for fuel cycle application

Preparation of U-Tc alloys by arc melting

UNLV | COLLEGE OF SCIENCES

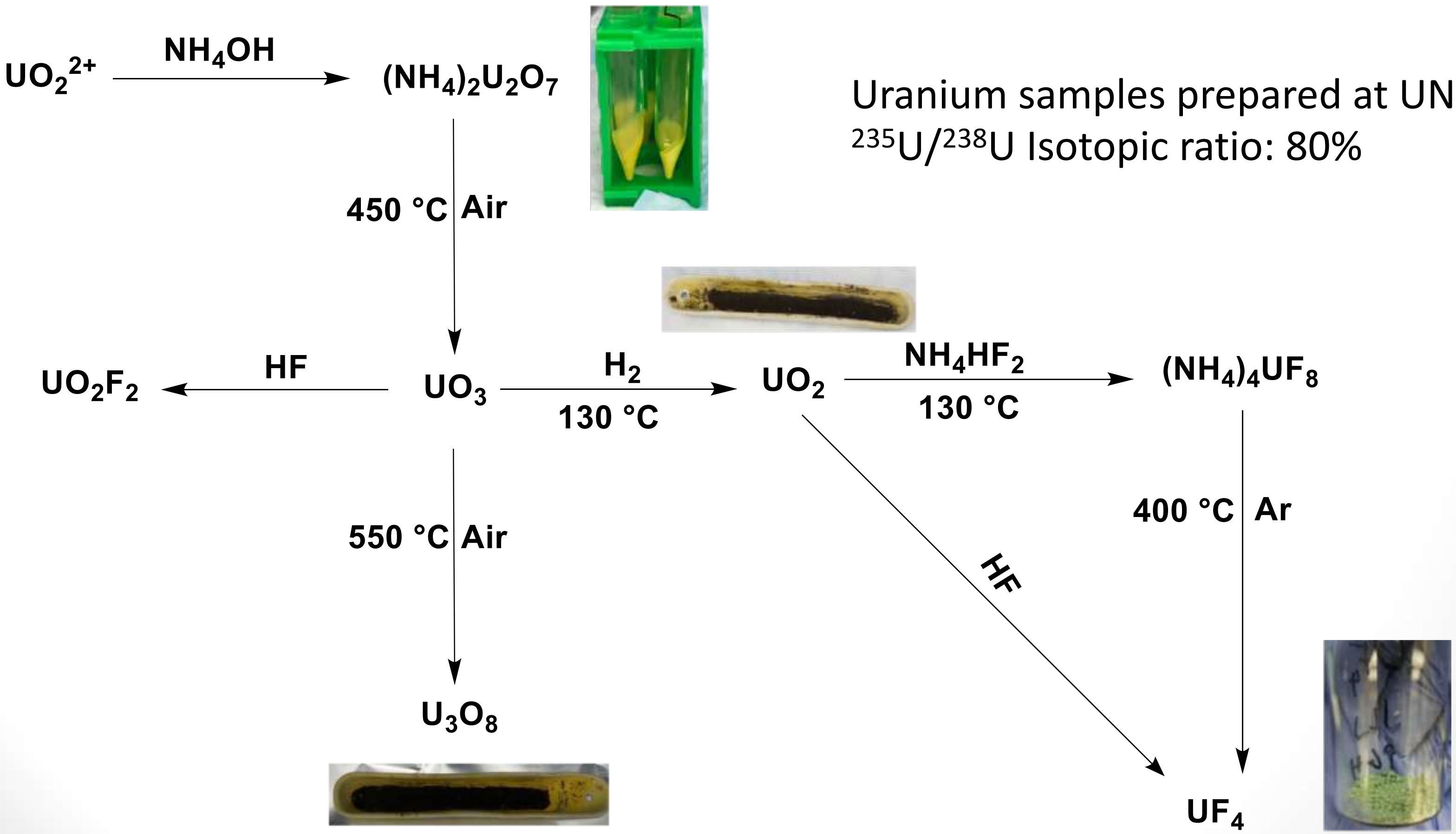
Technetium and Uranium Chemistry

Frederic Poineau, Ph.D.
Radiochemistry

→ Collaborative work relevant to nuclear forensics

Analysis of Uranium Isotopic Ratios by Thermal Ionization Mass Spectrometry (TIMS)

- Uranium compounds found throughout the fuel cycle (UO_2, U_3O_8, UF_4) prepared at UNLV
- $^{235}U/^{238}U$ isotopic ratio measurements using TIMS at LANL



Uranium samples prepared at UNLV
$^{235}U/^{238}U$ Isotopic ratio: 80%