





Nuclear Material Science

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NSSC3 Kickoff Meeting and Advisory Board Review April 19-20, 2022





The nuclear materials program has two major thrusts:

Advanced Manufacturing

• Does modern Manufacturing bring modern security risks?

Advanced Materials Characterization

• Does advanced characterization enhance the identification of a materials origin and/or properties?

- Advanced manufacturing
- Radiation effects in materials.
- Pre-detonation characterization
- Post detonation characterization



Key Personnel



Key Personnel: and Collaborators: P. Hosemann (Co-Lead, UCB), J. Stubbins (Co-Lead, UIUC); M. Asta (UCB), T. Horn (NCSU), D. Kaoumi (NCSU), O. Anderoglu (UNM).



National Laboratory Collaborators:

LANL: T. Saleh, S. Maloy, S. Vogel, W. J. Oldham, D. Podlesak, C. J. Montgomery, LBNL: A. Minor, M. Scott, LLNL: K. Holiday, J. Mckeown, B. Isselhardt, D. Weisz, K. Knight, I. Mathews SNL: K. Hattar















The Nuclear Material Science Faculty members have a number of on-going interactions at all of these national labs, however mostly with lab scientists outside the NNSA program

The Nuclear Material Science Faculty are in the process of developing interactions with NNSA scientists and research project at these labs

The Nuclear Material Science Faculty also have associations and collaborations with colleagues from other national labs (ANL, BNL, INL, PNNL, SRNL) where additional NNSA opportunities exist





Advanced Manufacturing

- Major capabilities of the Nuclear Materials Faculty in this area
- Active programs at all National Lab
- *Impact*: Security risks due to the ability to print complex components with special nuclear materials



Risk:





Advanced Manufacturing (*paste based printing*) *Impact*: Security risks due to the ability to print complex components with special nuclear materials or export-controlled materials.





Current print of H13 tool steel, Fe-Cr-Al alloy and Hastelloy -N (13 MEng students work on it this year 2021/22)



Advanced Manufacturing Laser Engineered Net shaping (*LENS*) *Impact*: Does the property change with the print?





Conversations with LLNL started on further engagement understanding the processing property relationships.

Data driven predictive property models are needed







UIUC, NCSU, UNM and UCB aim to develope a joint graduate-level class on additive manufacturing via remote teaching tools available for the wider audience (nat. lan, Univ,).







Pre-detonation Materials Characterization *Impact*: Use modern materials characterization to determine materials/component source. Femto-second laser ablation-MS for active samples is currently developed!

²³⁸¹ under continuous ablation along the axis of Sample

Laser ablation MS on fuel pellet B. Mason, P. Boone (UCB) & D. Weisz (LLNL)



3D TOF-neutron tomography LANL S. Vogel & A. Losko (LANL)







Post-detonation Materials Characterization *Impact*: Use modern materials characterization to determine materials/component source & origin (K. Knight, T. Genda - LLNL)





mean e⁺ implantation depth in Fe / nm

Research and Development Characterization



Irradiation Effects Impact: Use modern materials characterization to determine materials/component durability under irradiation. S. Stevenson - collaboration with S. Fensin (LANL).







Research and Development Irradiation



Deep ion implantation is needed to bridge experimental length scale gaps The LBL 88" Cyclotron enables rapid-turnaround testing of bulk nuclear materials A novel ion beam degrader is needed for uniform Helium implantation Allows for the study of bulk Helium effects of a variety of materials and sample sizes Water cooled to prevent annealing of samples and in-beam components Instrumented to monitor sample and in-beam component temperature Fits in an average Cyclotron beam box, ~1ft³





Research and Development Characterization



Irradiation Effects Impact: Use modern materials characterization to determine materials/component durability under irradiation. Mechanical properties Hi Vo - collaboration with Maloy,

Capolungo (LANL)



304 SS Microcompression Results - Same Orientation









NSSC 2 (Materials R&D): *Hi Vo*, Lab Fellow post doc at LANL *S. Stevenson*, will graduate during 2022/23, Bridge Fellow *Ethan Boado*, moves to DOE HQ *T. Genda, will graduate* during 2022/23 (LLNL) assigned

NSSC3 ongoing:

Darrin Parkinson, Summer 2022 at LANL as a lab student *Chai Peddeti*, LLNL lab student (affiliate) Expansion to UIUC, UNM, NCSU students

• Many joint publications on nuclear materials development, characterization, and fabrication

<u>Current Focus</u>: Develop stronger relation with NNSA Nuclear Materials Lab Scientists for interaction with the NSSC3 Nuclear Materials Faculty



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