Installation of A Novel High Throughput Micro and Macro Scale Machining Capability for Pre and Post Irradiation Examination

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Program: Infrastructure

ABSTRACT:
This project targets the deployment of a novel micro and macro scale high precision machining capability for unirradiated and irradiated materials. Cutting and shaping materials from in service components with a minimum amount of damage to the material and containing resulting radioactive debris while shaping conventional and advanced sample geometries for subsequent testing has been an expensive and difficult task. Especially targeting the mesoscale (larger than a few microns and smaller than mm) is difficult to tackle via conventional machining. Currently for larger geometries electrical discharge machining or milling is used while for small scale testing samples, focused ion beam machining is deployed. However, novel laser technology allows to manufacture macro to micro scale samples with no direct contact of a tool on the material and generate virtually any shape and form with less than 1μm deep surface damage. The fact that no tooling is used and the method is non-contact leads to advantages specific to the nuclear materials community such as no contaminated tools, no expensive consumables, no liquid radioactive waste, easy use of transparent containments structure just to name a few. While this technology has been deployed in the semiconductor and tool manufacturing industry it has not been used in nuclear materials investigations or research.
Therefore it is the aim of this proposal to purchase and install a femto second laser machining capability at the NSUF-UCB facility and make it available to all NSUF users and enable fast and effective sample processing with a minimum on surface damage that can easily be removed with subsequent efficient FIB work if needed.

Description of the Project:
Methods to be Employed: A femto second laser with the related optics, sample stage and software will be purchased and installed at the NSUF-UCB facility. The tool is ready to use from the vendor on any kind of metal or ceramic material. Sample geometries such as micro pillars, micro cantilevers, tensile dogbones or even TEM grits with sample can and will be manufactured on materials relevant to the nuclear materials community. Further we will work closely with the local environmental health and safety organization to machine also radioactive samples.
Potential Impact of the Project (i.e. benefits, outcomes, etc.): This tool will enable an orders of magnitude faster manufacturing of micro mechanical testing geometries and TEM sample manufacturing reducing the amount of FIB work needed. In addition it will allow to cut conventionally used geometries such as the SSJ2 tensile geometry from ORNL from in-service components with a minimum amount of damage to the sample.
Major Participants (for collaborative projects): The main participants in this project are Prof Peter Hosemann (PI) from the department of nuclear engineering bringing the nuclear materials expertise and NSUF facilities and Professor Costas Grigoropoulos from the department of mechanical engineering who is an expert in laser manufacturing and technology. Together we ensure the successful deployment of this novel machining capability for the nuclear materials community.


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