I/UCRC Executive Summary - Project Synopsis	**Date**: April 2022
Center/Site: CANFSA/Colorado School of Mines	
Tracking No.:60: The Fundamentals of Recrystallization in binary Nb alloys	**E-mail :** wwaliser@mines.edu **Phone :** (858) 401–3227
Center/Site Director: CANFSA/M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**
Project Leader: Will Waliser	**Proposed Budget**: $160,000
Project Description: Hafnium is used to suppress the recrystallization process in Nb-based superconducting alloys, but sustainable and effective alternatives have yet to be identified. A series of Nb binary alloys will be created to investigate the effects each alloying element has on the recrystallization parameters and microstructural evolution of niobium.	
Experimental plan: A series of binary Nb alloys will be made with Ti, Zr, Hf, V, Ta, Mo, W, and Re using an arc melter, which will then be rolled to achieve 60% reduction. Deformed samples will be heat treated and undergo recrystallization in the Gleeble, with microstructural evolution observed using EBSD and hardness values recorded at various stages throughout the experimental process.	
Related work elsewhere: Previous research documents solid solution strengthening elements, such as Re and Zr, inhibit grain growth and recrystallization in Nb. Additionally, elements known for relatively high thermodynamic activity such as V, Ti, or Hf can form nonmetallic compounds with impurities, which can cause similar effects.	
How this project is different: This project aims to directly investigate a series of metals with good solubility in Nb, to determine which elements are useful for stabilizing and/or retarding the grain kinetics during the heat treatment process. Additionally, the effects these alloying elements have on workability and work hardening behavior will also be documented, providing further information on the manufacturing viability of these alloys.	
Milestones for the current proposed year: Produce samples for testing, section and subject them to varying degrees of deformation while documenting resulting hardness values. Samples will then be heat treated at various temperatures and times, with microstructural evolution being observed using EBSD.	
Deliverables for the current proposed year: Show the effects each alloying element has on niobium’s microstructural evolution given various heat treatment parameters, as well as their effects on work hardening behavior. Identify which elements are good candidates for further investigation, and design a second set of binary/ternary alloy compositions as such.	
How the project may be transformative and/or benefit society: Further understanding of how alloying elements investigated affect the recrystallization parameters of niobium will provide useful information for future developments of refractory multi-principal element alloys and niobium-based superconductors such as Nb3Sn. Furthermore, without the restriction of constrained resources like Hf, achieving economies of scale becomes more viable when attempting to produce mass quantities of superconducting material for future accelerator projects.	
Research areas of expertise needed for project success: Access to an arc melting furnace, rolling mill, Gleeble for heat treatments, and a SEM for EBSD Rx measurements. Additionally, chemistry analysis w/ gasses will need to be carried out to verify the composition of the samples.	
Potential Member Company Benefits: Increasing the recrystallization temperature above the that of pure Nb would allow for a heavily worked structure to be retained in the final microstructure of a Nb3Sn superconductor. This finer grain structure would lead to increase flux pinning and improve the final performance of the superconductor. Additionally, further knowledge of how these alloying elements affect work hardening and grain kinetics in Nb may assist in alloy design for future RPMEA endeavors.	
Progress to Date: Training on all necessary equipment has been completed. Alloy compositions have been determined and a heat treatment plan for all samples has been designed. Several materials have arrived in various forms including Nb, Ti, V, Zr, Hf, Ta, and Mo, with the remaining materials arriving soon.	
Estimated Start Date: Fall 2021	**Estimated Knowledge Transfer Date**: Fall 2023