The Effect of Nuclear Environments on Select $M_{n+1}AX_n$ Phases

PhD Dissertation Proposal

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Robust materials are critical to meet evolving advanced reactor and fuel designs, which require materials to operate in the extreme environments of elevated temperatures, corrosive media, and high radiation fluences with lifetime expectation of greater than 60 years. Full understanding of material response to irradiation is paramount to long-term, reliable service. Mainly due to their good radiation tolerance and excellent creep resistance some ceramics, most notably SiC and its composites, are leading candidates for fuel cladding applications in a few of these reactors. However, these ceramics typically do not exhibit ductile or damage tolerance characteristics, complicating failure prediction. Adverse reactions to fission products also lead to complications. MAX phases are alternative candidate materials for these demanding environments either as a fuel matrix or coating material. There is potential for significant improvements in performance due to their high temperature capabilities, high damage tolerance, chemical resistance, and versatile manufacturing techniques. These ternary compounds provide exceptional performance margins for high temperature operations up to 1300°C, and also have metallic characteristics that provide advantages in mechanical and thermal design related characteristics. The focus of this proposal will be to characterize irradiated properties of select MAX phase compositions, and determine the compatibility they have with an assortment of reactor coolants and component materials.