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Diffusion, Thermal Properties and Chemical Compatibilities of Select MAX Phases with Materials for Advanced Nuclear Systems

PI: Michel Barsoum – Drexel University

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Collaborators: Dr. L. Hoffman, Savannah River National Laboratory, Dr. Robert Sindelar, Savannah River National Laboratory

ABSTRACT

A lead university and a DOE National laboratory will collaborate in an effort to develop a comprehensive set of chemical compatibility, diffusion and performance data in extreme environments of select MAX phases as potential alternatives to metals or SiC and its composites in advanced nuclear fuel and component designs for Gen VI reactors. The proposed deals with the following MAX phases: Ti_3SiC_2*, Ti_2AlC*, Ti_3AlC_2*, Ti_4AlN_3*, Ti_2SC*, Cr_2AlC and SiC fiber-reinforced Ti_3SiC2. The asterisks denote samples that are currently being neutron irradiated. In this work we will quantify the reactivities and interaction between the aforementioned MAX phases, both before and after neutron irradiation. The reactivities of these phases at high temperatures with He, molten Pb-Bi, Na and FLiBe will be studied. Diffusion couples of the MAX phases and U, Pd, pyrolytic C and SiC will also be studied at temperatures of 1000 °C and higher. The thermal conductivities and heat capacities of the MAX phases both before and after neutron irradiation will be quantified. Lastly, the permeation of deuterium and H2 in the 800 to 1000 °C temperature range through un-irradiated MAX phases will also be quantified. The proposed work complements on-going work on the mechanical behavior of these materials following irradiation of up to 9 dpa at irradiation temperatures up to 1000 °C. The non-irradiated physical properties will be performed at the university. Specimens in the irradiated condition will be tested and examined at the national lab. The final project deliverables are compendia of information on chemical compatibilities, fuel/fission product diffusivities, and thermal properties in non-irradiated and irradiated conditions for select MAX phases. This information will complement information on the mechanical response to neutron irradiation in progress by the same research team.