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Ion irradiation damage in commercially pure Titanium and Ti-6Al-4V: Characterization of the microstructure and mechanical properties

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Due to their low activation, corrosion resistance, good mechanical properties, and their commercial availability, Ti-alloys, especially the α+β alloy Ti-6Al-4V (wt%), are considered for different applications in nuclear industry. Ti-6Al-4V is also being considered as a structural material for the beam dump for the Facility for Rare Isotope Beams (FRIB) at Michigan State University- a new generation accelerator with high power heavy ion beams. In this study, samples of commercially pure (CP) Ti and Ti-6Al-4V that were processed through two different thermomechanical processes: powder metallurgy (PM) rolled and additive manufacturing (AM) were utlilized. The as-received samples exhibited two distinctly different microstructures. The powder metallurgy (PM) rolled sample had equiaxed α-phase grains with the β-phase typically present at the grain boundaries whereas the additive-manufactured sample showed a lamellar α +β microstructure. The samples were irradiated at Notre Dame University using 4 MeV Ar ion beam at 25℃ and 350℃. For the samples irradiated at RT, similar final dose of 7.3 dpa within the depth of 1 μm from the surface was obtained using two different dose rates of 0.8 dpa/h and 13.4 dpa/h. Nano-indentation measurements were carried out on the surface of the bulk samples to estimate the irradiation hardening. While CP-Ti exhibited the highest irradiation induced hardening, the nano-hardness of the additive-manufactured Ti-6Al-4V was found to be sensitive to the dose rate effect. To better understand the defect structure in the irradiated samples, 3 mm thin foils were prepared for the ongoing Transmission Electron Microscopy (TEM) characterization.

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