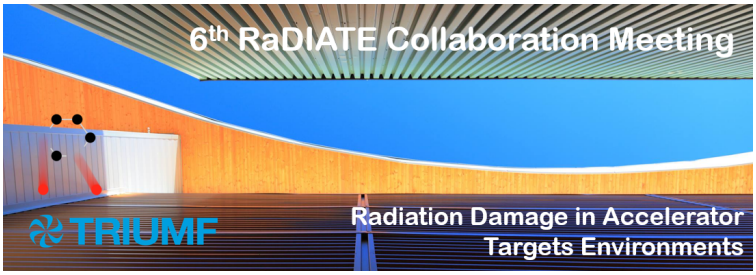

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Proton irradiation effects on the phase stability of (α+β) Ti-6Al-4V irradiated at BLIP using dilatometry and high energy X-ray diffraction techniques at the BNL synchrotrons

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Several super-alloys in the mid-Z range have been explored as targets for pion production to enable high-intensity neutrino sources. These allows have included Inconel-718, super-Invar, the Gum multi-functional alloys and the α+β titanium alloy Ti-6Al-4V.

In this presentation the phase stability of the Ti-6Al-4V following irradiation with 140 MeV protons at the Brookhaven Linac Isotope Producer (BLIP) is described.. Specifically, following two sequential irradiation phases with peak fluences of ~5x10^20 p/cm^2 along with post-irradiation annealing between irradiations, the influence of irradiation on the stability of α and β phases were studied using precision dilatometry. Subsequently, by using high energy X-rays at the BNL synchrotrons (NSLS and NSLS-II) along with Energy Dispersive X-Ray Diffraction (EDXRD) and X-Ray Diffraction (XRD) techniques (where the latter was augmented with a refined Rietveld analysis), the phase evolution of these materials was studied. In-situ stresses during X-ray diffraction were applied with both techniques to assess (a) the role of twinning in accommodating deformation in the hcp a phase of titanium and (b) the effect of strain on α/β phase content. These studies revealed (a) identifiable α to β transformations based on the thermal expansion coefficient evolution with temperature, (b) the influence of proton-irradiation on these transformations, (c) the appearance of the ω phase following proton irradiation, (d) a tension-compression asymmetry based on activation of the twinning mechanism, and (e) the influence of applied strain on α and β phase fraction.

Further studies of Ti6Al4V samples, in both their as-received state and after proton irradiation, are planned as part of an upcoming NSLS-II experiment. This experiment will utilize X-ray tomography to study the impact of variations in the in-situ multi-dimensional stress state as enabled by a specially designed stage. First results from the experiment, including the capabilities/features of the experimental set-up at the NSLS-II XPD beamline for X-ray tomography and XRD on irradiated materials will also be shown.

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