Modeling Activation and Radionuclide Decay in Proton Irradiated Zirconium Alloys

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Proton irradiation is an import tool in the study of radiation effects in materials due to the increased damage rates and greatly reduced activation compared to in-pile neutron irradiation. While activation by protons is generally low, and the activation products short-lived, radionuclides certainly are produced, and the residual activity increases with dose and proton energy. Due to the nature of the absorption cross sections, activation can be quite sensitive to the alloy composition of the samples. To this end, a computer simulation was developed to follow proton induced transmutation and the subsequent decay of zirconium alloys subjected to proton irradiation up to several MeV. The model is benchmarked to gamma spectroscopy results for Zircaloy-4 samples irradiated at 2 MeV, and predictions are made for select Zr-Nb alloys containing typical levels of minor alloying elements and impurities.