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P2.204 Results of 16 MeV proton irradiation on tungsten for fusion relevant damage

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Fusion first wall materials are required to withstand large neutron damage during their lifetime. This damage comprises of knock on induced displacement damage and a material composition change through transmutation reactions. Protons of up to 5 MeV and heavy ions from accelerators are capable of reproducing displacement damage similar to that from neutrons in a fusion reactor. As the accelerator produced protons register significantly higher damage rates than fission reactors, they are used to simulate the fusion neutron damage. Due to the low proton energy, the transmutation reactions are not reproduced and no change in material composition is observed. However, raising the proton energy above reaction thresholds, such as 16 MeV on tungsten, could introduce transmutation effects into the field of study. Higher energy simultaneously increases the damage depths to macroscopic levels of above 300 μm.

By varying the energy of the protons employed, a parameter study can be adapted at accelerators to understand the development of material changes through irradiation. In view of the above, a 16 MeV proton irradiation was undertaken, additionally serving the purpose of testing sample geometry, sample holder stability, heat removal, vacuum tightness and sample transport. All studies were simulated using MCNP6.1, FISPACT-II and SPECTRA-PKA calculations.

A macroscopic sample design was conceived to accommodate multiple tests within a single irradiation exposure. The sample sizes incorporated correspond to the recommended dimensions as prescribed in fission reactor studies. A real time temperature measurement system is incorporated within the sample holder. To obtain dose rate, activity levels and heat generation during and post irradiation, the entire setup was modelled in MCNP6.1.

The sample setup was tested with 16 MeV protons and analysed for mechanical property changes in the hot cells. These initial steps, including design of samples, holder and corresponding test results, will be presented in the talk.

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