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USING MULTI-ENERGY HELIUM IMPLANTATION TO STUDY HELIUM RETENTION AND SURFACE BLISTERING OF TUNGSTEN WITH REGARD TO FIRST WALL CONDITIONS IN AN INERTIAL FUSION ENERGY REACTOR

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Products of the fusion event in an inertial fusion energy reactor will irradiate the first wall, possibly causing surface blistering and exfoliation due to helium ion implantation and extreme temperatures. Tungsten is a candidate for the first wall material. Previous studies of helium retention and surface blistering with regard to dose, temperature, pulsed implantation, and tungsten microstructure have been conducted using monoenergetic ^3He ions. The helium implantation in the first wall of an actual IFE reactor will not be monoenergetic, but instead will have a continuous energy threat spectrum. Using a continuous energy threat spectrum to study helium retention and surface blistering of tungsten with regard to helium dose, temperature, pulsed implantation, and tungsten microstructure has been conducted to better understand what may occur at the first wall of the reactor. To create the desired continuous energy threat spectra during irradiation, thin graphite foils were placed in front of an ion beam and tilted according to a calculated angular motion profile to produce the desired relative doses of ion energies. As the monoenergetic ion beam passes through the graphite foil, the foil acts as an energy degrader, lowering the energy and spreading the energy profile of the transmitted beam to a Gaussian form. By approximating the energy threat spectra using Gaussian functions as a basis set, an angular motion profile was calculated relating the tilt of the foil to the relative dose of ions at certain energy. Single crystal and polycrystalline tungsten samples were irradiated with ^3He over ranges of 200- 1800 KeV in relative doses based on the theoretical energy threat spectra for an IFE reactor, with total doses ranging from $10^{19}/m^2$ to $10^{22}/m^2$. Implanted samples were analyzed by using neutron depth profiling.