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Energy differential and displacement damage cross section of DT neutron induced reactions on fusion reactor materials (Fe, Cr & W)

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Displacement per atom (dpa) in fusion reactor materials are essential designing parameters to ensure the reliable functioning and structural integrity of fusion reactor components. All probable reaction channels such as (n,n'), (n,2n), (n,p), (n,α) and (n,d) are open for the interactions of D-T neutrons of 14.1 MeV energy with the fusion reactor material. Evaluation of dpa requires energy spectra of recoil nuclei for each reaction channel. The iron, chromium, and tungsten are important materials widely proposed for structural and first wall components of the reactor. TALYS 1.8 and Empire3.2 codes have been used to calculate cross-section data and recoil spectra for each reaction channel. In the cross-section and spectra calculations, Contribution from all possible reaction mechanism such as direct, pre-equilibrium, compound and multiple emission reaction mechanisms have been considered. Prediction of σDPA requires energy differential cross section (EDX) of recoil nuclei from each reaction channel. EDX of emitted charged particles have been predicted and compared with the existing evaluated and experimental data from IAEA data Libraries to select the best fitted nuclear models and parameters. Energy spectra of recoil nuclei also considered as primary knock-on atoms for each reaction channel, have been predicted using the appropriate nuclear models and parameters in TALYS code for incident neutrons up to 15 MeV energy. PKA data have been used in NRT (Norgett Robinson and Torren), BCA (Binary collision approximation), BCA+MD (molecular dynamics) and kinetic monte carlo methods. Predicted σdpa is compared with the existing database of σdpa, prepared using the NJOY code. EDX data of each reaction channels are calculated for all stable isotope of Fe(54Fe, 56Fe, 57Fe, 58Fe), Cr(50Cr, 52Cr, 53Cr, 54Cr), and W(182W, 182W, 183W, 184W, 186W) and used for the prediction of σdpa for natural elements. For the experiments of DDX measurement of charged particles, neutron flux is measured with the diamond detector (efficiency = 0.00109% for the D-T neutrons). The efficiency of diamond detector has been measured with the alpha counting method using silicon surface barrier detector. Experiments for the DDX measurements are being carried out for natural iron and chromium.

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