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TRIGA Integral Activation of Mn foils, Li2O and LiF as Potential Tritium Production Monitors for Fusion Applications

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In the future fusion reactors, such as ITER or DEMO, tritium will be produced by bombardment of lithium atoms with neutrons and several types of special Tritium Breeder Modules (TBM) will be installed in the ITER reactor to demonstrate the self-sufficiency of tritium production. LiF pellets commercially produced as Thermo-luminescent detectors (LiF - TLDs) can be used to measure tritium production.
The similarities between the sensitivity profiles of the neutron reaction of tritium production in 6Li(n,t) and those of the 55Mn(n,g)56Mn reaction in the TBMs indicated that the latter reaction could be used as a tritium production monitor, at least for short-term monitoring, the half-life of 56Mn being 2.579 h. However, experimental verification and improvements and validation of the Mn cross-sections are needed in order to meet the required accuracy. In the scope of the Fusion for Energy (F4E) project of the European Commission, foils of certified reference materials Al-1%Mn and Al-0.1%Au, as well as TLD(LiF) and Li2O samples were irradiated in the JSI TRIGA research reactor, both bare, and under Cd and boron-nitride to study the potential use of Manganese detectors for monitoring the tritium production in fusion machines. In order to obtain complementary information for data validation purposes, the irradiations were performed in different neutron spectra, i.e. in the Central Channel, the Pneumatic Tube in position F24 in the outer "F"ring of the reactor core, in position F19 and in the IC-40 irradiation channel in the graphite reflector. Bare, and under Cd and boron-nitride irradiations were needed for the subtraction of epi-thermal neutron contribution in the 55Mn(n,g)56Mn reaction. Two series of measurements was performed, in 2014 and 2017. The transport calculations were performed using the Monte Carlo transport code MCNP6.1 with a detailed model of the TRIGA reactor including the irradiation capsules. The uncertainties involved in the measurements and the calculations were carefully evaluated. The principle objective was to study the energy response of the 55Mn(n,⊠)56Mn reaction and correlations between the Mn and TLD / Li2O measurements. Good consistency between the measured and calculated reaction rates, in most cases within the uncertainty bars, was observed and will be reported in the paper.

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