EXCITATION FUNCTION MEASUREMENTS FOR MN-52 PRODUCTION BY DEUTERON BEAMS IRRADIATION FOR THERANOSTIC APPLICATIONS

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Introduction

Manganese-52 is a radionuclide which decays with positron emission and electron capture, with a medium-long half-life ($T_{1/2}$ = 5.591 d). As a positron emitter, ^{52}Mn has a possible and promising use in Nuclear Medicine as a radiotracer for PET diagnostic tests, useful to investigate biological and physiological processes occurring on the same time scale of its decay; the low energy of the positrons emitted (244.6 keV) and the short range in the tissues (0.63 mm) would allow to acquire diagnostic images of a quality similar to those obtained with radiotracers already in use, such as Fluorine-18 (252 keV; 0.66 mm). Moreover, the stable isotope of manganese Mn^{2+}presents paramagnetic properties that make it suitable for use in MRI, opening the possibility of obtaining multi-modal PET / MEMRI images. Currently manganese is produced by irradiation with protons on chromium targets. We have studied the production by deuteron beams irradiation, that could be more advantageous.

Description of the Work or Project

We contribute with new measurements and data set to the database about the systematic study of the activation cross-sections of deuteron induced nuclear reactions, experimentally determining excitation functions of the ^{nat}Cr(d,x)^{52}Mn nuclear reaction. The stacked-foil activation technique irradiating at different energies thin targets of ^{nat}Cr was used. The chromium foils were prepared, with a nominal thickness of about 20 μm and a general relative uncertainty of ±2%, by the Department of Chemistry, Materials and Chemical Engineering "Giulio Natta" of Politecnico of Milan, by electro deposition on 16 μm thick Al foils. The true value of target thickness was measured accurately by weighing. The irradiations were carried out at the ARRONAX, Nantes, France (E_d up to 35 MeV and 750 μA intensity) at different incident energies with a constant current of about 150 nA for a duration of 1 h, in the energy range 6 – 29 MeV. The irradiated targets were analyzed at LASA Laboratory in Milano. The thin-target yields have been plotted as a function of their average energy into the targets and were fitted with the best mathematical functions. The integration of these functions allowed gaining the calculated thick-target yields, in order to find the optimized couple of energy irradiation and energy loss inside the thick target to maximize the production of the radionuclide of interest.

Conclusions

The possibility to produce ^{52}Mn using ^{nat}Cr(d,x) nuclear reaction is analyzed, using deuterons beams, that present indisputable advantages. A new set of excitation functions for this nuclear reaction was obtained and compared with the other sets present in literature and the results of simulation with EMPIRE 3.2.2 and TALYS (TENDL-2017) codes.

Keywords: nuclear medicine, accelerator produced isotopes, deuteron beams, Mn-52.