EXPERIMENTAL INVESTIGATION OF THE RADIOACTIVITY OF THE COPPER AND STAINLESS STEEL INDUCED BY CARBON BEAM IRRADIATION (200, 300, 400 MEV/U).

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Abstract

Activation of the structure of high power accelerators and of its surrounding are of serious concern. This activation is a direct result of beam loss occurring during normal operation: lost particles interact with the structure, producing a variety of radioactive species. These give rise to residual radioactivity. The species could potentially create large dose rates in the immediate area. The largest fraction of the induced radioactivity will be produced in the accelerator structure and in the beam transport components. Furthermore the induced gamma radioactivity provides the main contribution to the exposure dose for the personnel of high-energy heavy ion accelerators. The long living isotopes are accumulated in the accelerator construction materials and in principle determine the rate of decay of the induced radioactivity around the facility. In this case the exposure of the staff during access after the accelerator shutdown has to be measured.

In the range of the experiment 8 copper and stainless steel samples were irradiated by the primary beam of 200-400 MeV/u carbon ions.For the each ion energy and target material the total equivalent dose rate decay curve were measured by MAB-500 dosimeter with scintillator detector (Dose range: 50 nSv/h-100 mSv/h; Energy range for gamma: 33 keV -7.5 MeV. Mean values of "half-life" of short lived isotopes that determine the dose rate at the first time after irradiation for copper and stainless steel targets were estimated based on these data: copper - around 1030 s; stainless steel - 1270 s. The maximum dose rate 72 mSv/h was measured for stainless steel target after 6 min after the and of irradiation on the distance 25 cm from the source for the total fluency 1.33*1012 ions on the target.

Spectra measurements

The produced radioisotopes can be identified and quantified by the energies and square under the peak determining in the measurements of their characteristic g-rays. Precise gamma-spectrometry measurements for element identification is carried out with a Canberra HpGe-GEM-45195-S-SV detector powered by a Selena HV supply and interfaced to a Canberra spectroscopy amplifier. Data acquisition is processed via a software package WINGAM running on a PC. The spectrometer was preliminary energy and efficiency calibrated for 2 different distances 100 and 150 mm between the detector and gamma source. Namely this distances were used in the next spectra measurements.

In total, 80 spectra were measured for all targets within a 2 month after irradiation. The spectrum measurement time varied from 600 s up to 86400 s. For the element identification was used not only the energy position of gamma peak, but the experimentally measured decay curve parameters as well. Theoretical and experimental values are in the good agreement, thus we can identified the measured gamma lines with concrete nuclides. Several long-lived isotopes with half-life more than 100 days (notably 54Mn, 57Co,) were preliminary identified in the both irradiated materials for all energies and 60Co was found only in the copper targets.