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ABSTRACT

The activation products originated by protons of energies ranging from 15 MeV to 1.7 GeV on several crystals of interest to build the gamma imager of the INTEGRAL satellite are under measurement by the Exp. 261 collaboration, We have extracted the yield of production of medium and long lived radioactive products created during the irradiation at 1.7 GeV and measured in a low background HP-Ge spectrometer.

INTRODUCTION

The use of nuclear reactions that will transmute the **long lived nuclear wastes into less radioactive or shorter lived products is an alternative strategy** for the management of spent fuel of a nuclear power plant, **The transmutation of fission products into stable or shorter lived elements will be carried out by nuclear reactions induced by high energy particles as neutrons, protons, photons or light nuclei. The probability of these reactions is very low and will be of interest to know the excitation functions of the most favorable processes. Acceptable results may be obtained with very long irradiation time or very high fluxes of particles, in these processes the Z variation of the spallation products respect to the target is a strongly dependent function of the energy.**

In this sense we have studied the activation products originated by protons from 0.015 to 1.7 GeV on HgI_2, TeCd and CsI crystals and the conclusions will be of interest for the transmutation of long lived fission products.

EXPERIMENTAL METHOD

The experiments was carried out at the Saturn Laboratory at Saclay by the Exp. 261 collaboration. Small crystal of HgI_2 (1 x 1 x 0.1 cm^3 and 0.76 g), TeCd (0.5 x 0.5 x 0.2 cm^3 and 0.28 g) and CsI (1 x 1 x 1 cm^3 and 5 g) were irradiated with an estimated flux of $2.5 \cdot 10^{11}$, 0.62.1011 and 1-3.401011 protons of 1.7 GeV, respectively, deduced from values of cross sections for the Na-22 production by proton bombardment of Al-27 (1). Others previous data obtained at 0.015 (2) and 1.0 GeV are also reported.

The induced radioactivity in the crystals was measured four months after irradiation in the Environmental Radioactivity Laboratory at the University of Valencia using a low background 30°A HP-Ge spectrometer. The peaks identified in the spectra correspond to isotopes with half-life above 40 days.

RESULTS

The isotope identification was performed on the gamma spectra obtained for the crystals and are show in Table 1. For each isotope half-life and energy of the main gamma rays of the decay are given. The observed reaction products for the three crystals are mainly the same. As a number of 10-30 neutrons are generated by each incident proton (3), isotopes formed by secondary neutron capture, like 1-128 and Cs-134, have been also observed.

Gamma peaks from Hg reactions products are not seen in the measurements performed four months after the irradiation date.

We have compared our results with others measurements from irradiations of TeCd and CsI crystals with protons of lower energy (0.015 GeV and 1.0 GeV respectively) and we can see the different isotopes produced. The variation in Z and A of these products respect to the target is greather when the proton energy increases. In Table 2, is given the maximum variation in Z and A for the most important identified isotopes for three different experiments.

Finally we have calculated the production yield (per mol of the crystal and Per incident proton) of the identified isotopes during the irradiation using the activities measured and corrected by decay. These data are given in Table 1.

CONCLUSIONS

The energy of the incident protons is an important factor that determine the region of the isotope chart populated as result of the bombardment by protons of the target nucley. The short lived radionuclide production may be evaluated by mass spectrometry methods of the stable products of decay.

REFERENCES

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TABLE 1.-Identified isotopes four months after irradiation. (E = 1.7 GeV).

				PRODUCTION YIELD x 10-26 isotopes per incident proton and mol of the crystal		
Isotope	z	Half-life	E(keV)	HgI_2	TeCd	CsI
Be-7	4	53.30d	477.6	...	-----	2.0
Se-75	34	119.77d	136.1	2.5	5.3	9.4
Rb-83	37	86.20d	520.3	1.4	10.8	1.3
Sr-85	38	64.84d	514.0	---	10,0	0.9
Y -88	39	106.60d	898.0	1.5	10.5	1.7
Zr-88	40	83.40d	392.9	2.9	9.5	3.1
Ag-105	47	41 .29d	344.5	5.6	17.0	2.8
Sb-124	51	60.20d	602.7	---	4.2	
Te-121m	52	153.94d	212.2	2.0	4.0	2.3
Te-123m	52	119.70d	159.0	12.0	6.0	8.2
Xc-l 27	54	36.40d	202.9	---	-----	5.3
Cs-134	55	2.062y	604.6	---	-----	2.3

TABLE 2.-Maximum variation on Z and A of spallation products measured by gamma spectrometry.

	HgI_2		TeCd		CsI	
E(GeV)	AZ	AA	AZ	AA	AZ	AA
0.015	-	-	1	5	-	-
1.0			-		8	29
1.7	19	52	18	53	19	58