Mass and Isotopic yields for the reaction \(^{244}\text{Cm}(n_{th},f)\) at Lohengrin

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Recently, a new specific interest for fission yields of "minor" actinides arose, due to the development of new reactor technologies and transmutation projects of actinides and nuclear wastes. The SPIN program (for Séparation-11cénération) has been launched at the CEA (Commissariat à l'énergie atomique, France) to search for solutions allowing to partition and transmute long-lived radioactive waste in order to reduce their volume and toxicity and to investigate new fuel cycles. From the standpoint of the inventory of transuranium elements in Pressurised Water Reactor (PWR) and of their radiotoxicity, Curium and in particular Curium 245 is the third most important nuclide after Plutonium and Americium. Within these aspects we investigated the reaction \(^{244}\text{Cm}(n_{th},f)\) at the mass spectrometer Lohengrin. A new technique using an ionization chamber and an absorber field has allowed to measure the independent yields from A=84 (Se) up to Z=47 (Ag). Moreover, mass and kinetic energy distributions up to mass A=167 have been investigated. We present the measurement techniques and preliminary results.

1. Introduction

The inventory of transuranium elements in Pressurised Water Reactor fuels and their radiotoxicity shows that Curium (in particular \(^{244}\text{Cm}\)) is the third-most important nuclide after Plutonium and Americium. Several experimental efforts for measuring yields in thermal neutron induced fission of \(^{244}\text{Cm}\) have been made in previous years. Whereas the situation concerning chain yields and Americium has been investigated. We present a new reactor technologies and transmutation projects of actinides and nuclear wastes. The SPIN program for Séparation-11cénération has been launched at the CEA (Commissariat à l'énergie atomique, France) to search for solutions allowing to partition and transmute long-lived radioactive waste in order to reduce their volume and toxicity and to investigate new fuel cycles. From the standpoint of the inventory of transuranium elements in Pressurised Water Reactor (PWR) and of their radiotoxicity, Curium and in particular Curium 245 is the third-most important nuclide (after Plutonium and Americium). Several experimental efforts for measuring

2. Experimental setup

The initial target material which originated from PNNI in Gatchina, Russia, had an isotopic composition of 0.7 % for \(^{244}\text{Cm}\) and 99.3 % for \(^{245}\text{Cm}\) (± 10 %). The targets were prepared by electroplating of Curium in the form of CmO₃ on circular Titanium foils (diameter 3 cm, thickness 50 µm) in the shape of a round spot of 4 mm diameter. The cross section of \(^{244}\text{Cm}\) and of \(^{245}\text{Cm}\) for thermal neutrons is approximately 1.2 barns and 3000 barns respectively. The contribution of the first isotope to the activity measured in Nagoya is negligible compared in \(^{245}\text{Cm}\).

All experiments were performed at the Lohengrin mass spectrometer, Institut Laue Langevin (ILL), Grenoble, France. Figure 1 shows a mass separator for unseparated fission products, consisting of a condenser and a magnet [8], and is illustrated at the RED flux reactor in Grenoble which has a flux of 5.10^13 n.s.-1.cm^-2. The device makes use of electric and magnetic fields which are used to separate the fission products according to their mass number A, their kinetic energy \(E_K\) and their ionic charge \(Z\). The detectors were place at the end of the spectrometer. With the RED magnet used here was a stack of 12 foils Parylen G of thickness 200 µm, placed behind a tungsten grid, with 90 % of transmission was placed at the entrance of the chamber.

3. Measuring technique

It is known from [10] that solid absorbers have better separation power for different nuclear charges 2 that gaseous ones. The absorber used here was a stack of 12 foils Parylen C of thickness 40.05 µm (± 10 %) each. The main requirement of this material is to have a homogeneous surface which implies the same mass loss across the total area of the absorber. The only observation is the \(E_{\text{kin}}\) signal for fission fragments being stopped in the absorption chamber. The chamber was operated in the \(E_{\text{kin}}\) mode.

4. Results

Five targets with amounts of \(^{244}\text{Cm}\) ranging from 13 to 16 mg have been exposed to a thermal neutron flux of 5.10^13 n.s.^-1.cm^-2 for 10 days each. The targets were protected by a nickel foil of 0.25 mm which prevents spurring and uncontrolled loss of the target material. Isotopic yields have been measured from mass 85 to 115 for kinetic energies 92, 97, 102, 108, 113 and 118 MeV and for one or two isotopic charges: mass yields have been measured from A=130 to 167 for the whole kinetic energy and isotopic charge distributions. Results are presented in figure 5.

References
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