GAS AND VACUUM THERMOCHROMATOGRAPHY OF FISSION PRODUCTS

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The chemical behavior of $^{249}Cf(n_{th},f)$ fission products was studied on Ti, Fe, Ni, Nb, Mo, Ta, Re, quartz and sapphire surfaces at the TRIGA Mainz reactor using gas and vacuum thermochromatography. In the future a quartz transfer line could be used to retain Cs and In isobars in the on-line separation of Ag, Cd and Sn beams at ISOLDE.

INTRODUCTION

In recent years, very neutron-rich isotopes of silver (^{129,130}Ag [1,2]), cadmium (^{133}Cd [2]), indium (^{135}In [3]) and tin (^{137}Sn [4]) have been identified by resonant laser ionization at ISOLDE, and their half-lives were measured by detection of beta-delayed neutrons. However, detailed $\beta\gamma$–spectroscopy is still hampered by the omnipresent background of surface-ionized Cs and In isobars. In the present study, we have investigated various surfaces (metals, quartz and sapphire) for their suitability to retain these elements and thus increase the selectivity of the laser ionization by a chemical pre-separation. Earlier studies [5] proposed quartz surfaces for this purpose. This has been used for the first identification of ^{130}Cd at the old SC-ISOLDE facility at CERN in 1986 [6].

EXPERIMENTAL

The emphasis of this experiment was the thermochromatographic behavior of Ag, Cd and In. A ^{249}Cf target was chosen to optimize the production of suitable radiotracers (^{112,113}Ag, ^{117g,m}Cd and ^{117g,m}In) in thermal-neutron-induced fission. The fission products were produced at the TRIGA reactor in Mainz, extracted via a helium gas jet on carbon clusters and collected on a quartz filter. After 1-2 h collection time and ca. 1 h delay to let short-lived nuclides decay, a gamma assay of the filter was made. Radioisotopes of the elements strontium up to the lanthanides were detected. Then the filter was either inserted directly into a quartz or sapphire thermochromato-graphy (TC) column or, for the study of metal surfaces, distilled in a steep temperature gradient (from 1400 K to room temperature within few cm) onto a niobium catcher foil. The piece containing the activity of interest was then inserted into the TC column. The latter consisted either of a bare quartz or sapphire tube with 3 mm inner diameter or of a rolled metal foil inserted into a quartz tube, respectively.

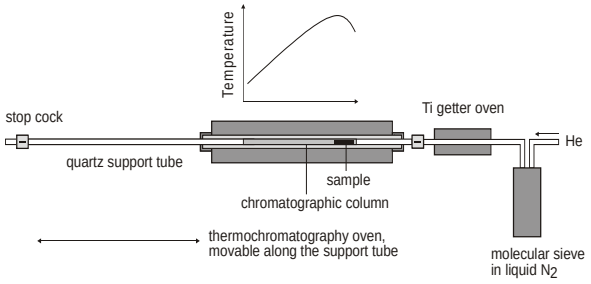

Fig. 1: Setup of the TC experiment at the TRIGA Mainz.

The samples were heated for 30 minutes in a negative temperature gradient of about –20 K/cm to maximum temperatures of 1325, 1375, 1475 or 1875 K, respectively, either in a flow (25 or 50 cm^3 per min) of pure He, in a reducing atmosphere of 93% He/7% H_2, or after evacuation to vacuum (<10^{-4} mbar). After cooling, the tubes were cut into pieces and the activity distribution was determined with an HPGe detector. The sapphire tube was not cut, but scanned through a Pb collimator.

RESULTS

As expected, cadmium was not retained on any of the surfaces, but left the heated zone. Cesium, however, was not released from the quartz filter even when heated up to 1875 K. Indium was found to be slightly more volatile on quartz surfaces than silver. Without H_2 addition, a second indium peak was observed at higher temperatures, probably corresponding to indium-oxide produced from oxygen impurities.

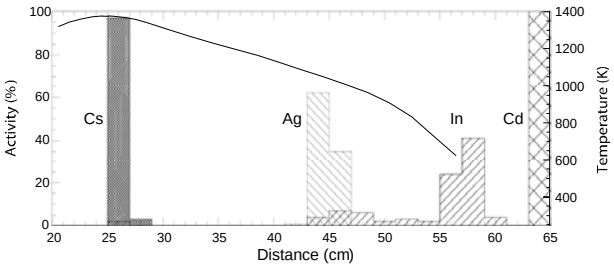

Fig. 2: The deposition of Ag, Cd, In and Cs on quartz surfaces.

OUTLOOK

The results suggest to use for future ISOLDE experiments with Cd beams a quartz transfer line between the target and the resonance ionization laser ion source. Hence, background from Cs isobars and of short-lived In isotopes could be suppressed by a large factor.

The same Cs suppression could be achieved when aiming for Ag or In isotopes, but the delay of the latter on a quartz surface will cause excessive delay losses for very short-lived isotopes. Therefore, the Cs retention on a sapphire surface (without temperature-limiting quartz) needs to be studied further.

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