

CHEMICAL IDENTIFICATION OF ELEMENT 106 BY THERMOCHROMATOGRAPHIC METHOD

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For the first time the chemical identification of element 106 has been accomplished. In comparative gas thermochromatographic studies of (oxo)chlorides of element 106 and of tungsten, reproducible groups of tracks of fission fragments from s.f. of $^{263}\text{106}$ were observed in a temperature region of 150—250 °C. This provides evidence that the element 106 oxochloride is similar to the tungsten compound. Elements 104, 105 and actinoids do not yield volatile compounds under the particular experimental conditions.

The investigation has been performed at the Flerov Laboratory of Nuclear Reactions, JINR.

Химическая идентификация элемента 106 термохроматографическим методом

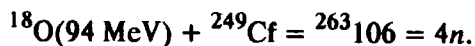
С.Н.Тимохин и др.

Впервые была выполнена химическая идентификация элемента 106. В сравнительных термохроматографических экспериментах с (окси)хлоридами элемента 106 и вольфрама наблюдали воспроизводимые зоны треков осколков спонтанного деления элемента 106 в интервале температур 150—250 °C. Это служит доказательством тому, что оксихлорид элемента 106 подобен аналогичному соединению вольфрама. Элементы 104, 105 и актиноиды не дают летучих соединений при данных экспериментальных условиях.

Работа выполнена в Лаборатории ядерных реакций им.Г.Н.Флерова ОИЯИ.

As an expected transition metal of group VI of the Periodic System, element 106 must form volatile chloride(s) and oxochloride(s). In experiments with isotopes of tungsten [1] we found a chemical system for selective separation of an oxochloride of W from Ln, Hf and Ta, which would serve the title goal.

Element 106 was produced at the U-400 cyclotron through the reaction



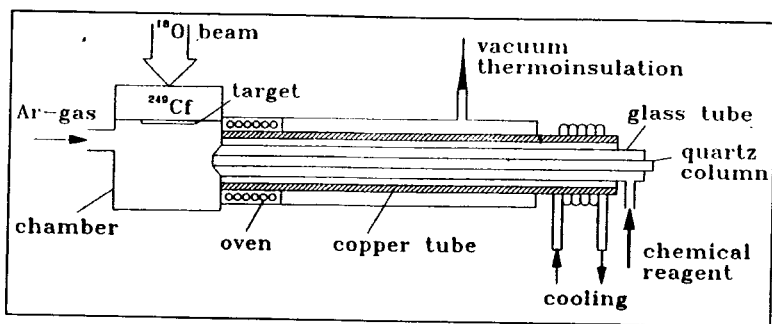


Fig.1

For $^{263}\text{106}$ a cross section of 0.4 at 94 MeV for the s.f. branch and $T_{1/2}$ of 0.9 s were reported [2]. The target contained 1.0 mg/cm^2 of radiochemically very pure ^{249}Cf . The ^{18}O beam intensity was about $3 \cdot 10^{12}$ pps. A schematic of our gas chromatographic equipment is shown in Fig.1.

The thermalized recoils were injected into a quartz thermochromatographic column with 1 l/min argon gas. As chemical reagents we used air (0.2 l/min) saturated with SOCl_2 (20 mmHg) vapors. The nuclide $^{263}\text{106}$ was registered through its s.f. events — the surface of the column itself served as the track detector of fission fragments.

In two experiments we put a quartz wool filter in the start zone (Fig.1, oven). No fission fragment tracks were found in the column. In subsequent two experiments such a filter was absent. This time, reproducible zones of tracks of fission fragments were observed in a temperature region of 150—250 °C (Fig.2), close to the deposition temperature of the $16\text{-s } ^{166}\text{W}^{-1}$ [1]. Then s.f. events during a 20-h bombardment and nineteen events in a 32-h one were registered in this region; in 3 and 6 cases, respectively, both fission fragments from an event were detected (see «black» events in Fig.2).

Essentially no tracks were found in the start zone and outside the indicated region of the thermal gradient. At the same time, various α -active actinoid isotopes ($^{252-254}\text{Fm}$, $^{253,254}\text{Es}$, ^{248}Cf) produced in the «transfer» reactions were seen mostly in the start zone ($\cong 99\%$), i.e. the 106/An separation was as required.

The yields of ^{252}Fm , ^{256}Fm and ^{256}Md and recoiling from the particular target versus energy were measured for 91 to 104 MeV ^{18}O ions using catcher foils and direct counting of relatively long α -active and s.f. nuclides. The results are summarized in the Table. Our yields for the $^{252,256}\text{Fm}$ drop

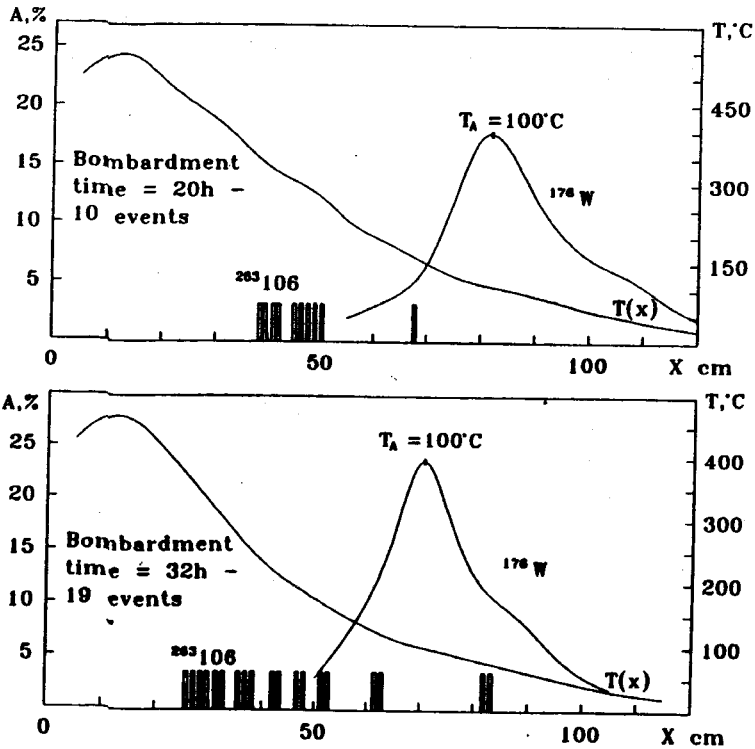


Fig.2

Table. Production cross sections for $^{252,256}\text{Fm}$ and ^{256}Md (in μb)

		91 MeV	94 MeV	97 MeV	104 MeV
Lee (LBL):	^{252}Fm	610	—	1910	2400
	^{256}Fm	0.11	—	1.2	1.5
	^{256}Md	0.07	—	0.69	0.19
Sagaidak (FLNR):	^{256}Fm	—	0.002	0.02	0.02
	^{256}Md	—	0.02	0.2	0.2
This work (FLNR):	$^{256}\text{Fm} + ^{256}\text{Md}$	10^{-4}	10^{-4}	0.02	0.02
	^{252}Fm	$2 \cdot 10^{-4}$	0.7 ± 0.3	43 ± 4	36 ± 4

sharply with the energy decreasing from 97 to 91 MeV. In the Table, the cross sections from D.Lee et al. [3] and R.Sagaidak et al. [4] are also given. The results of various authors in the Table cannot be directly compared

because the transfer reaction products have broad angular and projected range distributions, hence the recoil yield depends on the thickness of the target, which was not the same in the cited studies. The data need a separate evaluation.

We also made two 3-h bombardments at 94 MeV, in which the reaction products were carried by inert gas and deposited in a cold column. No fission events were detected in the column: i.e., the total yield of «background» s.f. activities with $Z < 106$ and half-lives longer than some 0.1 s does not exceed the yield of element 106.

Our data seem to confirm the formation of an element 106 oxochloride similar in properties to the tungsten compound. One should bear in mind ^{176}W that has a half-life of 2.5 h, and due to this it is deposited at much lower temperature than a 0.9 s tungsten activity would be. Unfortunately there is no way to produce ^{166}W or even shorter tungsten isotopes simultaneously with element 106.

In the first two «unsuccessful» experiments, obviously, the retention time on the filter exceeded $T_{1/2}$ of $^{263}\text{106}$. Longer retention on filters was observed earlier also for elements of groups IV and V.

Thus, for the first time the chemical identification of element 106 was accomplished. Both the experiments with Hf and Ta and our earlier studies of elements 104 and 105 in very similar chemical systems exclude the possibility that the latter two transactinoid elements might be responsible for the observed fission events.

References

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