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Gas chromatography of element 113

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The discovery of new superheavy elements with Z = 113-118 in 48Ca induced nuclear reactions was one of the most outstanding scientific achievement of the last decade. The long halflives of radionuclides of these elements extend the application of radiochemical techniques to their chemical characterization and to test the hypothesis about the impact of so-called “relativistic effects” on the chemical properties of superheavy elements [1]. According to Periodic Table element 113 belongs to group 13and its ground state electronic structure is [Rn]5f146d107s27p1 (i.e. homolog of Tl). Modern relativistic calculations predict weak adsorption on inert surfaces due to strong contraction and stabilization of surface 7 p1/2 orbital(adsorption enthalpy on Teflon is 14 kJ/mol, and on polyethylene 16 kJ/mol) [2]. At the same time due to relativistic stabilization 7p1/2 and high spin-orbital splitting of 7p element 113 has to easily be adsorbed (in H2/He) on Au surface (adsorption enthalpy is - 158.6 kJ/mol) [1]. Taking this into consideration we studied a gas chromatography of the given upwards theoretical predictions of element 113 properties, its adsorption of element 113 on a Au surface was studied compared to Hg and At (similar as in the case of Cn and Fl [3, 4]).
The reaction 48Ca + 243Am was used to produce nuclides 288115 and its daughter 284113 [5]. Nuclear reaction products were stopped in a He / Ar gas mixture and atoms of volatile elements were transported by the gas jet through a Teflon capillary to chromatography column. Gas chromatographic column is a two-detector system consisting of Si detectors covered with gold. First detector operated at room temperature (20℃) and the second one with a temperature gradient from +20° C to -60 ° C. A total of five chains of 284113 was detected in the first isothermal detector. Adsorption enthalpy of element 113 on gold surfaces is comparable with that of mercury, which indicates that element 113 is a volatile metal and weakly interacts with inert surfaces. The probabilities for a random origin are 7.6x10e-3, 6.6x10e-5, 2x10e-4, 6.7x10e-10, 5.7x10e-6 calculated using Poisson distribution [6].Direct formation of nuclide 284113 in irradiation of 243Am with 48Ca in multi-nucleon transfer reactions (18 protons and 23 neutrons) is virtually impossible. From this we can deduce that isotopes of 113-111-109-107-105 elements detected in the experiment are daughters of mother nuclide 288115 synthesized in a reaction 243Am(48Ca,3n).
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