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Thermochromatographic investigation of ¹¹³In, ¹²⁵Sb and ^{125m}Te in quartz columns

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Investigation of chemical properties of super heavy elements (SHE) produced in 48Ca induced nuclear fusion reactions with actinide targets [1-4] represents a challenging task for chemists world wide. In the present research an experimental determination of dHads. of carrier-free 113mIn, 125Sb and 125mTeO2 species on quartz surface was performed.

Lighter homologues of SHE elements 113mIn(T1/2=99 min), 125Sb(T1/2=2.7582 y) and 125mTe(T1/2=57.40 d) were prepared by using neutron irradiation facilities at PSI. For that purposes 0.5 g of nat-Sn were irradiated at the SINQ-NAA at PSI for 2 h. The irradiated sample was used as source for thermochromatographic investigations with quartz as stationary surface. Different experimental conditions (carrier gases, gas mixtures and flow rates) were used to investigate of chemical behaviour of indium, antimony, and tellurium species. Specially designed gradient oven allowed to achieve a temperature gradient in the range between 1300 ℃ up to -140 ℃.

The interaction of metallic antimony and indium with quartz surfaces was investigated using a highly purified hydrogen gas to exclude trace amounts of water and oxygen. The entire thermochromatography column was encapsulated in a steel tube. The gas had to pass a Ta getter (1000℃) before hitting the tracer source deposited on Al2O3 and heated up to 1300℃. Afterwards, the released isotopes were transported again over a hot Ta getter. This setup supposed to ensure the elemental state for the quite reactive antimony. Reproducibility of obtained data was achieved by several repetitions of the experiment at the same conditions. It was found that deposition temperature Sb in elemental state is 580 0C, what is the in good agreement with literature data, whereas deposition temperature for In is rather higher (Tdep.=710 ℃) than it was reported [6]. After data collecting, Monte-Carlo simulation approach [7] was applied to obtain the adsorption enthalpy of the species on quartz surfaces at zero surface coverage (dHads). Calculated enthalpy of adsorption for In was -235 kJ/mol and for Sb was -205 kJ/mol. Using H2/H2O gas mixture it was possible to determine deposition temperature of 113In(OH) (Tdep.= 320 ℃) and 125Sb(OH)3 (Tdep.= 360 ℃). Such a deposition temperature results in dHads(InOH)= -145 kJ/mol and dHads(Sb(OH)3)= 155 kJ/mol. The interaction of tellurium species with quartz surfaces investigated using O2/H2O gas mixture. 125mTeO2 was deposited at 590 ℃ resulting in an enthalpy of adsorption dHads(TeO2)= -205 kJ/mol. The data obtained The data obtained in the previous research will be useful for the design of experimental set-ups for gas chromatographic experiments with real superheavy elements, especially E113-E115.

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