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

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Investigation of chemical properties of super heavy elements (SHE) produced in ^{48}Ca 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 ^{113}In , ^{125}Sb and $^{125\text{m}}\text{TeO}_2$ species on quartz surface was performed.

Lighter homologues of SHE elements $^{113\text{m}}\text{In}$ ($T_{1/2}=99$ min), ^{125}Sb ($T_{1/2}=2.7582$ y) and $^{125\text{m}}\text{Te}$ ($T_{1/2}=57.40$ 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 °C up to -140 °C.

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°C) before hitting the tracer source deposited on Al_2O_3 and heated up to 1300°C. 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 °C, what is the in good agreement with literature data, whereas deposition temperature for In is rather higher ($T_{\text{dep.}}=710$ °C) 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 $\text{H}_2/\text{H}_2\text{O}$ gas mixture it was possible to determine deposition temperature of $^{113}\text{In}(\text{OH})$ ($T_{\text{dep.}}=320$ °C) and $^{125}\text{Sb}(\text{OH})_3$ ($T_{\text{dep.}}=360$ °C). Such a deposition temperature results in $\text{dHads}(\text{InOH})=-145$ kJ/mol and $\text{dHads}(\text{Sb}(\text{OH})_3)=-155$ kJ/mol. The interaction of tellurium species with quartz surfaces investigated using $\text{O}_2/\text{H}_2\text{O}$ gas mixture. $^{125\text{m}}\text{TeO}_2$ was deposited at 590 °C resulting in an enthalpy of adsorption $\text{dHads}(\text{TeO}_2)=-205$ kJ/mol. 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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