Gas Phase Chemical Search for Element 112 in the Ca-48 induced Nuclear Fusion Reaction with U-238

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Element 112 is claimed to be directly produced in the ^{48}Ca-induced nuclear fusion reaction with ^{238}U [1-3]. First experiments performed at the Flerov Laboratory of nuclear reactions (FLNR) Dubna, Russia and at the Gesellschaft für Schwerionenforschung (GSI) Darmstadt, Germany have been focused on the 5-min spontaneously fissioning (SF) ^{283}112. In the experiments at FLNR a volatile spontaneously fissioning species was observed [4,5] and attributed to ^{283}112. In the experiments at GSI we used a modified and improved In-situ Volatilization and On-line detection (IVO) setup, which was already applied for the chemical investigation of Hassium (Hs) [6]. These measurements were not free of background. However, evidence was achieved for high energetic decays from a chemical species accumulated at a defined very low temperature of about -170 °C [7,8]. We were not able to conclusively attribute these events to the decay of ^{283}112, since a SF-fragment spectroscopy at these low temperatures was affected by thick ice layers on the detectors.

The recent observation of a 4-s α decay branch of the isotope ^{283}112 followed by a 200-ms SF of ^{279}Ds at the FLNR Dubna [9] brought up the question, what species we observed in the first experiment, which was sensitive only to species with half lives longer than 25 s. Moreover, the long-lived SF decay was not confirmed in the recent experiments in Dubna [9]. In experiments performed at the Lawrence Berkeley National Laboratory (LBNL), using the Berkeley gas filled Separator (BGS) the production of ^{283}112 in the reaction of ^{48}Ca on ^{238}U was not confirmed [10,11]. However, the newly observed exceptionally specific decay mode of a short α-SF or α-α-correlation (about 10% α-decay branch for ^{279}Ds was also observed at FLNR Dubna) offered the unique chance to unambiguously identify ^{283}112 in a chemistry experiment. We significantly improved our experimental setup with respect to speed and detection efficiency in order to be able to observe a species with a half life >2 s and measuring genetically linked time-correlated decay chains, thanks to a 4π counting geometry. Also, the depletion of carrier gas contaminants was mandatory in order to investigate the interaction of element 112 with the chromatographic gold surface. The experiment with element 112 was conducted at GSI Darmstadt in Sept./Oct. 2004. A 1.6-mg/cm^2 ^{238}U (uranium oxide) target was irradiated with an estimated ^{48}Ca beam dose of $1.4*10^{18}$. The beam energy inside the target was 227-243 MeV with 235 MeV at the center of the target. The dedicated newly developed set-up performed well. The gas phase transport and chemical separation was performed within 2.5 s. Hence, we achieved a transport yield of 65 % for a 4-s isotope of a volatile element (similar to Hg or Rn). The detection efficiency for a coincident SF event was about 64 %. For α decay the detection efficiency was close to 82 %. The deposition yield of a Hg-like activity was about 100 %, whereas a Rn-like species was deposited with about 85%. The overall yield of detecting a Rn-like (Hg-like) element 112 decaying by 4-s α-SF was estimated to be about 38% (44%). We did not observe any short-lived α-SF or α-α correlations. No coincident SF signals have been detected. We observed 4 high energetic single events in the detectors, each with no preceding alpha decay in the energy range from 9.0-12.0 MeV within 3 s. During the 16.8-day background measurement no such high energetic events were registered. Nevertheless, the 4 observed events cannot be attributed to a SF-decay of ^{283}112 or ^{279}Ds since only the detection of coincident signals in top and bottom detectors are considered real fissions. The statistical analysis of the result is ongoing.

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