Contribution ID: **220** Type: **Verbal**

Production of 261Rf, 262Db, and 265Sg for chemical studies using GARIS at RIKEN

Monday, 12 May 2014 14:30 (15 minutes)

Recently, chemical characterization of superheavy elements (SHEs) with atomic numbers Z ≥ 104 is an extremely interesting and challenging research subject in modern nuclear and radiochemistry [1,2]. At RIKEN, we have been developing a gas-jet transport system coupled to the RIKEN gas-filled recoil ion separator GARIS as a novel technique for SHE chemistry [3–5]. This system is a promising approach for exploring new frontiers in SHE chemistry; (i) background radioactivities originating from unwanted by-products are strongly suppressed, (ii) an intense primary heavy-ion beam is absent in the gas-jet chamber and hence a high gas-jet yield is achieved, and (iii) the beam-free conditions also make it possible to investigate new chemical reactions. In this work, we investigated production and decay properties of long-lived radioisotopes of Rf (Z = 104), Db (Z = 105), and Sg (Z = 106) available for chemical studies [6–9]. Oxygen-18, 19F, and 22Ne beams were extracted from the RIKEN linear accelerator. The isotopes of 261Rfa,b, 262Db, and 265Sga,b were produced in the reactions of 248Cm(18O,5n)261Rfa,b, 248Cm(19F,5n)262Db, and 248Cm(22Ne,5n)265Sga,b, respectively. The evaporation residues of interest were separated in flight from the beam particles and the majority of the nuclear transfer products by GARIS and were guided to a gas-jet chamber at the focal plane of GARIS. The evaporation residues were then thermalized in He gas, attached to KCl aerosol particles, and were extracted through a Teflon capillary to the chemistry laboratory. Alpha and spontaneous fission (SF) decays of 261Rfa,b, 262Db, and 265Sga,b were measured with the rotating wheel apparatus MANON under low background conditions. In the conference, perspectives of the next-generation SHE chemistry opened by GARIS will be also presented.

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Session Classification: Chemistry of Actinide and Trans-actinide Elements 1

Track Classification: Chemistry of Actinide and Trans-actinide Elements