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Development of a liquid scintillation detection system for aqueous chemistry of seaborgium

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As relativistic effects on the valence electrons become large in heavy elements, it is interesting to elucidate chemical properties of the transactinide elements. In these chemical experiments, an automated and rapid chemistry apparatus coupled to an α -particle detection system is required. In the present study, we have developed an on-line liquid scintillation detection system to measure solution samples eluted from the chemistry apparatus for aqueous chemistry of element 106, seaborgium (Sg).

We fabricated a liquid scintillation detector which consists of a photomultiplier tube and a glass cell set in a semispherical reflector. The nuclide ^{265}Sg decays by α -particle emission and the daughter nuclide, ^{261}Rf , decays by α -particle emission or spontaneous fission (SF). Therefore, to detect both α particles and SF fragments is required for the determination of Sg. Energy resolution and detection efficiency in α -particle detection were measured using the nuclides ^{226}Ra and ^{241}Am . Response to the SF events was investigated using the nuclide ^{252}Cf . Procedures in on-line measurements are as follows. An emulsifier scintillator was first introduced into the cell. The aqueous solution sample from the chemistry apparatus was then injected to the cell. During the injection, the scintillator and the solution sample were mixed with an electromagnetic stirrer. Measurement was started after the mixture became homogeneous in the cell. The above procedures were automatically and repeatedly performed.

The present detection system was applied to the on-line measurement of ^{213}Fr ($T_{1/2} = 34.6$ s) produced in the $^{209}\text{Bi}(^{16}\text{O}, 4n)^{221}\text{Pa}$ reaction using the AVF cyclotron at RCNP. The reaction products were transported to the chemistry laboratory by a He/KCl gas-jet system and were collected on the collection site of the ion-exchange apparatus, ARCA, for 1 min. The collected products were then dissolved in 200 μL of 0.1 M $\text{HNO}_3/5 \times 10^{-3}$ M HF solution for 12 s. The eluent was transferred to the cell and mixed with 4 mL of the scintillator. Start of measurement of the products was approximately 15 s after the end of collection.

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