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Automated rapid α/SF detection system for studying aqueous chemistry of superheavy elements at RIKEN

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The extremely low production yields and short half-lives of superheavy element (SHE) nuclei force us to perform rapid, efficient, and repetitive chemical experiments with single atoms. We plan to start the study of the aqueous chemistry of SHEs such as 261Rf, 262Db, and 265Sg using the RIKEN AVF Cyclotron. In this work, we have developed an automated α/spontaneous fission (SF) detection system that can be coupled to various aqueous chemistry apparatuses. This system consists of a storage column of Ta dishes for holding sample solutions, a round table for sixteen Ta dishes, i.e., a sample collection port, and sixteen detector chambers for the detection of α-particles and/or SF fragments. Beside the round table, we set up the appropriate aqueous chemistry apparatus. The SCARA robot (Yamaha YK500XG) picks up a Ta dish from the storage column through suction and positions it on the round table. The table is rotated to position the dish at the desired port for sample collection, and the solution, typically ˜200 μL for each dish, is rapidly dried by using hot helium gas and a halogen heat lamp. Then, the robot transfers the dish to the detector chamber, which is equipped with a Si PIN photodiode (Hamamatsu S3204-09) and a preamplifier (Hamamatsu H4083). The detector chamber is closed promptly and evacuated, and −50 V is applied to the detector from a complex module comprising a power source and a gate generator (Vacuum Products GG-10001). The whole system is controlled by a programmable logic controller (Keyence KV-3000), and each action can be triggered by relay contact signals from a separate controller of the chemistry apparatus. The time required to start the measurement after drying the sample is about 5 s. Each detector has a counting efficiency of 36%. The α-energy resolution is about 50-keV FWHM at 5.486 MeV.

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