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Redox studies of the heaviest elements using an electrolytic column apparatus

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Redox studies of the heaviest elements are fascinating because they provide information on the binding energies of the valence electrons which are expected to be influenced by increasingly strong relativistic effects. All heavy elements with atomic number ≥ 101 are produced in heavy-ion induced nuclear reactions. They are only available as short-lived radioisotopes and only as single atoms. This means that standard electrochemical techniques are not applicable to redox studies of the heaviest elements. Therefore, we have developed a novel technique of electrolytic column chromatography. While passing through one column, single ions undergo electrolytic oxidation or reduction and are chromatographically separated according to their oxidation states. In this paper, we will present the electrolytic reduction of trivalent mendelevium (Md, element 101) and the oxidation of divalent nobelium (No, element 102) using our newly developed flow electrolytic column apparatus. All experiments were carried out at the JAEA tandem accelerator in Tokai. Redox reactions of Md and No, between the 2+ and 3+ states, were clearly observed. Redox potentials of these elements were successfully determined based on observed amounts of the oxidized or reduced state as a function of the applied potential. In the preparation of future experiment with seaborgium (Sg, element 106), we recently began a study on the reduction of the lighter group-6 homologs Mo and W using an electrolytic column apparatus. Our recent results of the reduction of Mo and W will be also presented.

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