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Determination of the first ionization potentials of heavy actinides based on an atom at a time scale

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The first ionization potential (IP_1) is one of the most sensitive atomic properties which reflect the outermost electron configuration. Precise and accurate determination of IP_1 of heavy elements allows us to give significant information on valence electronic structure affected by relativistic effects. The IP_1 values of heavy elements up to einsteinium (Es, Z=99), produced in a nuclear reactor in macroscopic quantities were successfully measured by resonance ionization mass spectroscopy. IP1 values of heavy elements with Z≥100, however, have not been determined experimentally, because both half lives and production rates of nuclides of still heavier elements are rapidly decreasing, which forces us to manage elements on an atom-at-a-time scale. In the present study, we report the determination of the IP_1 values of heavy actinides from fermium (Fm, Z=100) through lawrencium (Lr, Z=103) using a surface ionization technique. The surface ion-source installed in JAEA-ISOL (isotope separator on-line) was applied for measuring the ionization of the short-lived nuclides ^{249}Fm (half-life $T_{1/2}$=2.6 min), ^{251}Md ($T_{1/2}$=4.27 min), ^{257}No ($T_{1/2}$=24.5 s), and ^{256}Lr ($T_{1/2}$=27 s) that were produced in the ^{243}Am + ^{11}B, ^{243}Am + ^{12}C, 248C_m + ^{13}C, and ^{249}Cf + ^{11}B reactions, respectively, at the JAEA tandem accelerator. The number of ions collected after the mass-separation was determined by α-particle spectroscopy to evaluate ionization efficiencies. The obtained IP_1 values are in good agreement with those predicted by state of the art relativistic calculations as well as with early prediction. The contribution will present experimental details and results obtained in this study.

Biography

Yuichiro Nagame is currently Senior Associate of Advanced Science Research Center in Japan Atomic Energy Agency and Professor of Ibaraki University. He received a PhD degree in 1982 with a study of strongly damped collision mechanism in heavy ion induced nuclear reactions from Tokyo Metropolitan University. His research interests are chemical and nuclear properties of the heaviest elements, nuclear fission, heavy ion induced nuclear reactions and so on. He served as a Chairman of Japan Society of Nuclear and Radio chemical Sciences during 2010-2012. He was an IUPAC Associate Member from 2000 to 2001, and is a Member/Fellow of IUPAC since 2002.

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