

Production of seaborgium isotopes in the reaction of $^{30}\text{Si}+^{238}\text{U}$

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Seaborgium isotopes were produced in the reaction of $^{30}\text{Si} + ^{238}\text{U}$ by using the velocity filter SHIP, and the production cross-sections were determined. The beam of $^{30}\text{Si}^{6+}$ was prepared from enriched material, ^{30}SiO (enrichment 99.5 %), at the 14 GHz ECR ion source. The beam intensities were typically 0.7 – 1.0 μA . The experimental set-up is essentially the same as in previous experiments [1].

The uranium targets were prepared by evaporation of $^{238}\text{UF}_4$ on 45 $\mu\text{g}/\text{cm}^2$ carbon backing. The $^{238}\text{UF}_4$ target layers had thickness of 375 – 404 $\mu\text{g}/\text{cm}^2$.

The focal plane detectors were used to measure the recoil implantation and the subsequent alpha decays or spontaneous fission (sf). Behind the focal plane detector, we mounted a clover detector consisting of four Ge crystals. Due to the high multiplicity of gamma-rays emitted from the fission fragments, coincident gamma-ray are observed with a probability of 80%.

We used three different reaction energies of $E_{c.m.}=144.0$, 133.0 and 128.0 MeV, which were chosen so that the energy yields the maximum of the ER cross-sections for 5, 4, and 3n channel excitation functions according to a statistical model calculation. The accumulated beam doses were 1.8×10^{18} , 4.0×10^{18} and 1.7×10^{18} , respectively.

The observed decay chains or sf events are shown in Fig. 1. At $E_{c.m.}=144.0$ MeV, we observed three alpha decay chains from ^{263}Sg (event number 1, 2, 3 in Fig.1), produced by five neutron emission. The energy and half-life agree with the literature values [2,3]. The cross-section for ^{263}Sg was 67(+67-37) pb. We also observed sf (No. 4), which we tentatively assign to ^{262}Sg . The cross-section was 22(+51-18) pb.

At the lower reaction energy of $E_{c.m.}=133.0$ MeV, we observed four sf events (No. 5, 6, 7 and 8). Three events from No. 5 to No. 7 have similar lifetime, and the half-life is determined to be 120(+126-44) ms. The excitation energy of the compound nucleus is 11 MeV less than in the case of 144.0 MeV reaction energy, so that we assign these events to the new isotope ^{264}Sg . We obtained a cross-section of 10(+10-6) pb for ^{264}Sg . The sf of No. 8 has longer half-life. We tentatively assign this sf to ^{261}Rf , daughter of ^{265}Sg produced in the 3n channel. The cross-section for this event was 3.5(+8.1-2.9) pb.

At the lowest energy of $E_{c.m.}=128.0$ MeV, no decay events were measured. We determined an upper cross-section limit of 15 pb at 68% coincidence level.

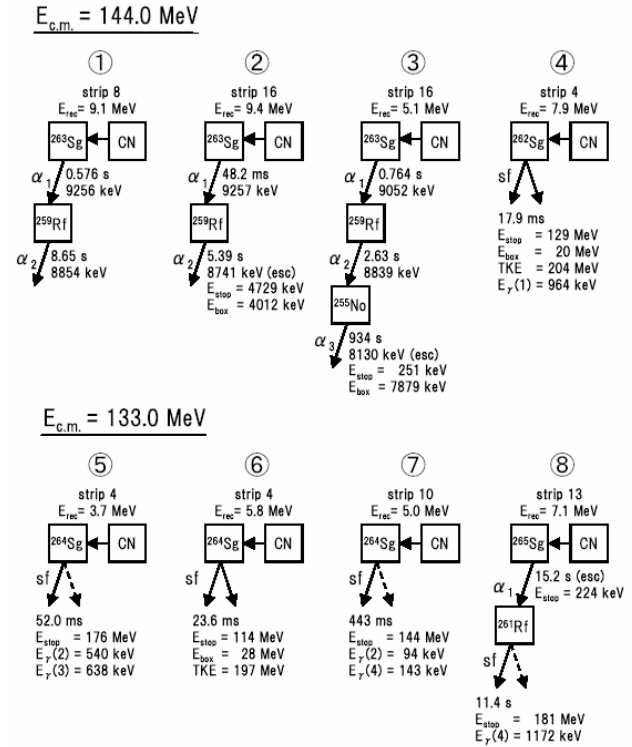


Figure 1: The observed decay chains or spontaneous fission events in the reaction of $^{30}\text{Si}+^{238}\text{U}$.

The cross-sections are compared to a statistical model calculation which takes into account the prolate deformation of ^{238}U in the capture process. It is found that the collision of ^{30}Si with the equatorial side of ^{238}U results in complete fusion without any significant fusion hindrance, whereas competition between fusion and quasifission is present at collisions with the tips of ^{238}U . Detailed discussion is given in our publication [4].

References

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