Production and Decay of ^{265}Sg and ^{266}Sg

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Predictions of enhanced nuclear stability[1] due to deformed nuclear shells near N=162 and Z=108, have recently been confirmed with the detection[2] of ^{265}Sg and ^{266}Sg using the Dubna gas-filled separator. In the Dubna experiments, the ^{265}Sg and ^{266}Sg half-lives were not measured (although α-decay systematics indicated half-lives between 2-s and 30-s). In addition, the measured production cross sections for the ^{248}Cm(^{22}Ne,4-5n)$^{266-265}$Sg reactions were accurate to only a factor of three.

The estimated half-lives for ^{265,266}Sg, together with the production cross sections of ~100pb, make measurement of the chemical properties of Sg possible for the first time. Measurement of the half-lives, and refinement of the production cross sections are important in the understanding of the strength and extent of the N=162 deformed shell, and necessary in planning for the chemical experiments.

In experiments at the LBNL 88-Inch Cyclotron, we searched for ^{265}Sg and ^{266}Sg produced in the ^{22}Ne + ^{248}Cm reaction at ^{22}Ne bombarding energies of 116- and 121-MeV. Activities recoiling out of the target were transported with a He/KCl gas-jet to the MG rotating wheel system where we looked for the following decay chains: $^{265}\text{Sg} \Rightarrow {}^{261}\text{Rf}+\alpha \Rightarrow {}^{257}\text{No}+\alpha \Rightarrow {}^{255}\text{Fm}$ and $^{266}\text{Sg} \Rightarrow {}^{262}\text{Rf} \Rightarrow$ fission. At the MG, the activities were collected on 50-μg/cm^2 polypropylene foils at the periphery of a 20" diameter wheel, which was periodically stepped to advance the newly collected sources between pairs of ion-implanted Si detectors.

A parent-daughter stepping mode was used to provide unambiguous identification of the decay of ^{266,265}Sg. In this mode, upon detection of a potential Sg α-event in a bottom detector, it is assumed that the corresponding Rf daughter atom recoils into the top detector. The source is then removed from the detector station to allow detection of the daughter-atom α-decay in a background-free environment.

In these experiments, the gas-jet efficiency was found to be 70% by measuring the detection rates of ^{254,256}Fm (binary transfer products) and ^{213,214}Ra (compound nucleus products from a Pb impurity in the target). In addition, the efficiency for collecting α-daughter recoils in the top detector upon detection of an α-particle in the bottom was found to be ~70% by monitoring the ^{211,212}Ra -> ^{207,208}Rn decay chains.

At the 116-MeV bombarding energy (where ^{266}Sg was observed in the Dubna experiments), we observed no correlated α-fission pairs, indicating an upper limit for the ^{266}Sg of 25 pb (95% confidence limit). This is below the lower limit reported in the Dubna experiment.

At the 121-MeV bombarding energy (where ^{266}Sg and ^{265}Sg were observed in the Dubna experiments), We performed two experiments. In the first, we observed one decay chain from ^{266}Sg, and background problems prevented positive assignment of four candidate events to the decay of ^{265}Sg. In the second experiment, two decay chains were observed which are unambiguously assigned to the decay of ^{265}Sg.

E_α Sg (keV)	τ Sg (sec)	E_α Rf (keV)	τ Rf (sec)	E_α No (keV)	τ No (sec)	
8690	3.809	SF	0.875			^{266}Sg
8840	5.640	8250	28.51	8280	37.68	^{265}Sg
8860	25.80	8185	56.5			^{265}Sg

From these results, we conclude that ^{265}Sg and ^{266}Sg are formed in 121-MeV ^{22}Ne + ^{248}Cm bombardments with cross sections of ~200 pb and ~100 pb, respectively.

Footnotes and References

1. R. Smolanczuk, et al., Phys. Rev. C 52, 1871 (1995).
2. Yu. A. Lazarev, et al., Phys. Rev. Lett. 73, 624 (1994).