A Chemical Study of Bohrium Using ~1-s ^{266}Bh

R. Eichler, Ch. Düllmann, B. Eichler, H. W. Gäggeler, D. T. Jost, D. Piguet, A. Türler, K. E. Gregorich, V. Ninov, C. M. Folden III, U. W. Kirbach, C. A. Laue, D. M. Lee, J. B. Patin, R. Sudowe, P. A. Wilk, H. Nitsche, D. C. Hoffman, A. B. Yakushev, S. Hübener, S. Taut, A. Vahle, W. Brüchle, and M. Schädel[1]

In 1999, the desire to understand the chemistry of bohrium (Bh, element 107) initiated a search for isotopes with half-lives on the order of seconds that could be used for chemical studies. The discovery of 17-s ^{267}Bh [2] led to a collaboration of researchers from several European countries and the United States who showed that bohrium forms an oxychloride compound similar to technetium and rhenium and can be placed in its predicted position on the periodic table as a group seven element [3]. The current experiment sought to use ~1-s ^{266}Bh in a similar experiment, allowing for both the study of its decay properties and the confirmation of bohrium's assignment to group seven.

At the Paul Scherrer Institute (PSI, Switzerland) a ^{249}Bk (478 μg/cm^2) target, provided by LBNL, was irradiated with a total of 0.84×10^{18} ions of 121-MeV (lab frame, center of target) ^{22}Ne^{6+} at 250 enA from the Philips cyclotron. Fig. 1 shows a schematic of the experimental setup. Reaction products were transported from the recoil chamber via carbon clusters in a flowing stream of helium. A mixture of O_2 and HCl was added to the helium stream prior to implantation on quartz wool in a reaction oven at ~1050 °C. Here group seven elements are expected to form highly volatile compounds of MO_3Cl, where M = Tc, Re, and Bh, and re-enter the gas phase. These oxychlorides were transferred to a 230-°C isothermal chromatography column also made of quartz. Volatile products exiting the column were collected on CsCl aerosols for transport by argon to the ROMA (vertical rotating wheel) detection system. The ROMA was operated in parent-daughter mode with 1.5-s parent steps and 120-s daughter modes. During the entire experiment, product yield was monitored via gamma spectroscopy of the neutron-deficient isotope ^{176}Re that was produced by reaction of the ^{22}Ne beam with a layer of ^{159}Tb (100 μg/cm^2) that had been deposited on the target.

Analysis is ongoing but has yielded only one α–α correlation so far. It has yet to be determined whether this represents a true event or a random correlation. The total system efficiency measured during the experiment was low (~8%) and may be attributed to weak adsorption of the volatile oxychlorides on the surface of the CsCl recluster aerosols at higher helium gas temperatures. In addition, ^{266}Bh may have a half-life substantially shorter than 1 s and decay during the several-second trip from the target to the ROMA. The absence of events that can be conclusively attributed to ^{266}Bh prevents us from making any new statements concerning the chemical properties of bohrium.

Footnotes and References

1. This collaboration included scientists from LBNL, the University of California, Berkeley (USA), PSI (Switzerland), the University of Bern (Switzerland), GSI (Germany), FZR (Germany), and FLNR (Russia).
2. P.A. Wilk et al., *Phys. Rev. Lett.*, **85**(13), 2697 (2000).
3. R. Eichler et al., *Nature*, **407**, 63 (2000).

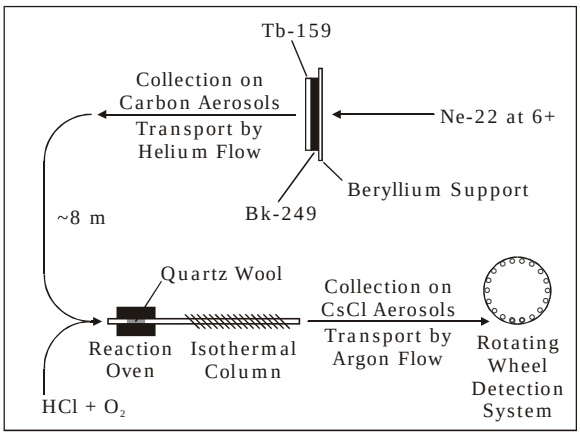

Fig. 1. Schematic of the experimental setup.