Chemistry of Superheavy Elements

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I. Production of Superheavy Elements

a. Theoretical calculations show that half-lives of superheavy isotopes increase with increasing neutron number. For example for A=290 isotope of element 114 is calulated to have a half-life of ~10 days [1].

b. Limited data at GSI show that using more neutron rich projectiles on 208Pb increases the cross section. For example, Ge-84 on 208Pb has estimated cross section of 1 nb for the production of element 114.

c. For chemistry experiment, a thick target can be used, thus utlising the whole peak of the excitation function instead of using just one point.

d. Estimated beam intensity of Ge-84 is 2.7x10**9

Using the above information, we estimate a production of 10 atoms in 10 days. This will be sufficient for chemical studies. For lower Z elements, more atoms are expected by this procedure.

The understanding of chemical properties of these elements are interesting by themselves but because these are very high Z elements, relativistic effects are more pronounced and hence such effects can be tested. In absence of relativistic effects, element 114 should have properties of its homolog Hg and Pb. At present the heaviest element chemically studied is Seaborgium (Z=106).

II. Study of more neutron-rich nuclei

Using very neutron-rich beam and 238U, 244Pu and 248Cm target, very neutron-rich fission fargments could be produced. One interesting case is the fission of 264Fm which will split into two doubly magic 132Sn fragments. Thus very high yields of 132Sn and nuclei around it is expected. In addition, because of the highest N/Z ratio in any fissioning system, the A distribution will peak 2 neutrons higher than the distribution for the most neutron-rich fissioning system now. Thus two more heavier isotopes of each element will be studied. This nucleus could be produced by irradiation of 244Pu with

20C beam. For example, with this approach it will be possible to study 135Sn and 136Sn which have three and four more neutrons than the doubly closed 132Sn
Structures of these nuclei will be performed with a gamma-ray array like GAMMASPHERE. This experiment will provide identification of levels with moderate spin, which is not possible by measuring radiations associated with the decay of the mass separated isotopes of fission products.

1. R. R. Chasman and I. Ahmad, Phys. Lett. B392, 255 (1997)
2. S. Hofmann, Rep. Prog.Phys. 61, 639 (1998).
3. E. P. Horwitz and C. A. A. Bloomquiat, J. Inorg. Nucl. Chem. 37, 425 (1975).

Cheng-Lie gave me the folwing beam intensities on April 26, 2000

Ge-84	7.7x10**8	at 100 MeV/u
	1.3x10**9	200
	2.0x10**9	300
	2.7x10**9	400
Be-14 (4 ms)	3.5x10**7	400 MeV/u
C-18 (17 ms)	5.2x10**8	400 MeV/u
C-20	6.4x10**4	
C-22	3.1x10**2	
O-22 (3 s)		
O-24 (61 ms)	5.0x10**5	at 400 MeV/u