Bohrium

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Bohrium is a chemical element with symbol **Bh** and atomic number 107. It is named after Danish physicist Niels Bohr. It is a synthetic element (an element that can be created in a laboratory but is not found in nature) and radioactive; the most stable known isotope, ^{270}Bh, has a half-life of approximately 61 seconds.

In the periodic table of the elements, it is a d-block transactinide element. It is a member of the 7th period and belongs to the group 7 elements as the fifth member of the 6d series of transition metals. Chemistry experiments have confirmed that bohrium behaves as the heavier homologue to rhenium in group 7. The chemical properties of bohrium are characterized only partly, but they compare well with the chemistry of the other group 7 elements.

Bohrium, $_{107}Bh$

General properties	
Name, symbol	bohrium, Bh
Bohrium in the periodic table	
Atomic number (*Z*)	107
Group, block	group 7, d-block
Period	period 7
Element category	□ transition metal
Standard atomic weight (A_r)	[270]
Electron configuration	[Rn] $5f^{14}$ $6d^5$ $7s^2$ [1][2]
per shell	2, 8, 18, 32, 32, 13, 2
Physical properties	
Phase	solid *(predicted)*[3]
Density near r.t.	37.1 g/cm^3 *(predicted)*[2][4]
Atomic properties	
Oxidation states	**7**, (**5**), (**4**), (**3**)[2][4] (parenthesized oxidation states are predictions)
Ionization energies	1st: 742.9 kJ/mol 2nd: 1688.5 kJ/mol 3rd: 2566.5 kJ/mol

Isotopes

Bohrium has no stable or naturally occurring isotopes. Several radioactive isotopes have been synthesized in the laboratory, either by fusing two atoms or by observing the decay of heavier elements. Eleven different isotopes of bohrium have been reported with atomic masses 260–262, 264–267, 270–272, and 274, one of which, bohrium-262, has a known metastable state. All of these decay only through alpha decay, although some unknown bohrium isotopes are predicted to undergo spontaneous fission.[14]

The lighter isotopes usually have shorter half-lives; half-lives of under 100 ms for ^{260}Bh, ^{261}Bh, ^{262}Bh, and ^{262m}Bh were observed. ^{264}Bh, ^{265}Bh, ^{266}Bh, and ^{271}Bh are more stable at around 1 s, and ^{267}Bh and ^{272}Bh have half-lives of about 10 s. The heaviest isotopes are the most stable, with ^{270}Bh and ^{274}Bh having measured half-lives of about 61 s and 54 s respectively. The unknown isotopes ^{273}Bh and ^{275}Bh are predicted to have even longer half-lives of around 90 minutes and 40 minutes respectively. Before its discovery, ^{274}Bh was also predicted to have a long half-life of 90 minutes, but it was found to have a shorter half-life of only about 54 seconds.[14]

The proton-rich isotopes with masses 260, 261, and 262 were directly produced by cold fusion, those with mass 262 and 264 were reported in the decay chains of meitnerium and roentgenium, while the neutron-rich isotopes with masses 265, 266, 267 were created in irradiations of actinide targets. The four most neutron-rich ones with masses 270, 271, 272, and 274 appear in the decay chains of ^{282}Nh, ^{287}Mc, ^{288}Mc, and ^{294}Ts respectively. These eleven isotopes have half-lives ranging from about ten milliseconds for ^{262m}Bh to about one minute for ^{270}Bh and ^{274}Bh.[22]

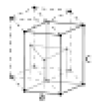
Predicted properties

Chemical

Bohrium is the fifth member of the 6d series of transition metals and the heaviest member of group 7 in the Periodic Table, below manganese, technetium and rhenium. All the members of the group readily portray their group oxidation state of +7 and the state becomes more stable as the group is descended. Thus bohrium is expected to form a stable +7 state. Technetium also shows a stable +4 state whilst rhenium exhibits stable +4 and +3 states. Bohrium may therefore show these lower states as well.[4] The higher +7 oxidation state is more likely to exist in oxyanions, such as perbohrate, BhO_4^-, analogous to the lighter permanganate, pertechnetate, and perrhenate. Nevertheless, bohrium(VII) is likely to be unstable in aqueous solution, and would probably be easily reduced to the more stable bohrium(IV).[2]

Technetium and rhenium are known to form volatile heptoxides M_2O_7 (M = Tc, Re), so bohrium should also form the volatile oxide Bh_2O_7. The oxide should dissolve in water to form perbohric acid, $HBhO_4$. Rhenium and technetium form a range of oxyhalides from the halogenation of the oxide. The chlorination of the oxide forms the oxychlorides MO_3Cl, so BhO_3Cl should be formed in this reaction. Fluorination results in MO_3F and MO_2F_3 for the heavier elements in addition to the rhenium compounds $ReOF_5$ and ReF_7. Therefore, oxyfluoride formation for bohrium may help to indicate eka-rhenium properties.[23] Since the oxychlorides are asymmetrical, and they should have increasingly large dipole moments going down the group, they should become less volatile in the order TcO_3Cl > ReO_3Cl > BhO_3Cl: this was experimentally confirmed in

	(more) *(all but first estimated)*[2]
Atomic radius	empirical: 128 pm *(predicted)*[2]
Covalent radius	141 pm *(estimated)*[5]
Miscellanea	
Crystal structure	hexagonal close-packed (hcp) *(predicted)*[3]
CAS Number	54037-14-8
History	
Naming	after Niels Bohr
Discovery	Gesellschaft für Schwerionenforschung (1981)



Most stable isotopes of bohrium

iso	NA	half-life	DM	DE (MeV)	DP
^{274}Bh	syn	~54 s[6]	α	8.8	^{270}Db
^{272}Bh	syn	9.8 s	α	9.02	^{268}Db
^{271}Bh	syn	1.2 s[7]	α	9.35[7]	^{267}Db
^{270}Bh	syn	61 s	α	8.93	^{266}Db
^{267}Bh	syn	17 s	α	8.83	^{263}Db

2000 by measuring the enthalpies of adsorption of these three compounds. The values are for TcO_3Cl and ReO_3Cl are −51 kJ/mol and −61 kJ/mol respectively; the experimental value for BhO_3Cl is −77.8 kJ/mol, very close to the theoretically expected value of −78.5 kJ/mol.[2]

Physical and atomic

Bohrium is expected to be a solid under normal conditions and assume a hexagonal close-packed crystal structure ($^{c}/_{a}$ = 1.62), similar to its lighter congener rhenium.[3] It should be a very heavy metal with a density of around 37.1 g/cm^3, which would be the third-highest of any of the 118 known elements, lower than only meitnerium (37.4 g/cm^3) and hassium (41 g/cm^3), the two following elements in the periodic table. In comparison, the densest known element that has had its density measured, osmium, has a density of only 22.61 g/cm^3. This results from bohrium's high atomic weight, the lanthanide and actinide contractions, and relativistic effects, although production of enough bohrium to measure this quantity would be impractical, and the sample would quickly decay.[2]

The atomic radius of bohrium is expected to be around 128 pm.[2] Due to the relativistic stabilization of the 7s orbital and destabilization of the 6d orbital, the Bh^+ ion is predicted to have an electron configuration of [Rn] $5f^{14}$ $6d^4$ $7s^2$, giving up a 6d electron instead of a 7s electron, which is the opposite of the behavior of its lighter homologues manganese and technetium. Rhenium, on the other hand, follows its heavier congener bohrium in giving up a 5d electron before a 6s electron, as relativistic effects have become significant by the sixth period, where they cause among other things the yellow color of gold and the low melting point of mercury. The Bh^{2+} ion is expected to have an electron configuration of [Rn] $5f^{14}$ $6d^3$ $7s^2$; in contrast, the Re^{2+} ion is expected to have a [Xe] $4f^{14}$ $5d^5$ configuration, this time analogous to manganese and technetium.[2] The ionic radius of hexacoordinate heptavalent bohrium is expected to be 58 pm (heptavalent manganese, technetium, and rhenium having values of 46, 57, and 53 pm respectively). Pentavalent bohrium should have a larger ionic radius of 83 pm.[2]

Experimental chemistry

In 1995, the first report on attempted isolation of the element was unsuccessful, prompting new theoretical studies to investigate how best to investigate bohrium (using its lighter homologs technetium and rhenium for comparison) and removing unwanted contaminating elements such as the trivalent actinides, the group 5 elements, and polonium.[24]

In 2000, it was confirmed that although relativistic effects are important, bohrium behaves like a typical group 7 element.[25] A team at the Paul Scherrer Institute (PSI) conducted a chemistry reaction using six atoms of ^{267}Bh produced in the reaction between ^{249}Bk and ^{22}Ne ions. The resulting atoms were thermalised and reacted with a HCl/O_2 mixture to form a volatile oxychloride. The reaction also produced isotopes of its lighter homologues, technetium (as ^{108}Tc) and rhenium (as ^{169}Re). The isothermal adsorption curves were measured and gave strong evidence for the formation of a volatile oxychloride with properties similar to that of rhenium oxychloride. This placed bohrium as a typical member of group 7.[26] The adsorption enthalpies of the oxychlorides of technetium, rhenium, and bohrium were measured in this experiment, agreeing very well with the theoretical predictions and implying a sequence of decreasing oxychloride volatility down group 7 of $TcO_3Cl > ReO_3Cl > BhO_3Cl$.[2]

$$2\,Bh + 3\,O_2 + 2\,HCl \rightarrow 2\,BhO_3Cl + H_2$$

Source

- Wikipedia: Bohrium (https://en.wikipedia.org/wiki/Bohrium)