Oganesson

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Oganesson (symbol **Og**) is a transactinide chemical element with the atomic number 118. It was first synthesized in 2002 by a joint team of Russian and American scientists at the Joint Institute for Nuclear Research (JINR) in Dubna, Russia. In December 2015, it was recognized as one of four new elements by the Joint Working Party of international scientific bodies IUPAC and IUPAP. It was formally named on 28 November 2016.[10][11] The name is in line with the tradition of honoring a scientist and recognizes nuclear physicist Yuri Oganessian, who has played a leading role in the discovery of the heaviest elements in the periodic table. It is one of only two elements named after a living person at the time of naming, the other being seaborgium.[12]

Oganesson has the highest atomic number and highest atomic mass of all known elements. The radioactive oganesson atom is very unstable, and since 2005, only four atoms of the isotope ^{294}Og have been detected.[13] Although this allowed very little experimental characterization of its properties and possible compounds, theoretical calculations have resulted in many predictions, including some surprising ones. For example, although oganesson is a member of group 18 – the first synthetic one to be so – it may possibly not be a noble gas, unlike all the other elements of that group.[1] It was formerly thought to be a gas under normal conditions but is now predicted to be a solid due to relativistic effects.[1] On the periodic table of the elements it is a p-block element and the last one of the 7th period.

Oganesson, $_{118}$Og

General properties	
Name, symbol	oganesson, Og
Oganesson in the periodic table	
Atomic number (Z)	118
Group, block	group 18, p-block
Period	period 7
Element category	unknown, but predicted to be a noble gas
Standard atomic weight (A_r)	[294]
Electron configuration	[Rn] $5f^{14}$ $6d^{10}$ $7s^2$ $7p^6$ *(predicted)*[1][2]
per shell	2, 8, 18, 32, 32, 18, 8 *(predicted)*
Physical properties	
Phase	solid *(predicted)*[1]
Boiling point	350±30 K (80±30 °C, 170±50 °F) *(extrapolated)*[1]
Density when liquid, at m.p.	4.9–5.1 g/cm^3 *(predicted)*[3]
Critical point	439 K, 6.8 MPa *(extrapolated)*[4]
Heat of fusion	23.5 kJ/mol *(extrapolated)*[4]
Heat of vaporization	19.4 kJ/mol *(extrapolated)*[4]
Atomic properties	
Oxidation states	−1,[2] 0, +1,[5] **+2**,[6] **+4**,[6] +6[2]

Characteristics

Nuclear stability and isotopes

The stability of nuclei decreases greatly with the increase in atomic number after plutonium, the heaviest primordial element, so that all isotopes with an atomic number above 101 decay radioactively with a half-life under a day, with an exception of dubnium-268. No elements with atomic numbers above

82 (after lead) have stable isotopes.[46] Nevertheless, because of reasons not very well understood yet, there is a slightly increased nuclear stability around atomic numbers 110–114, which leads to the appearance of what is known in nuclear physics as the "island of stability". This concept, proposed by University of California professor Glenn Seaborg, hypothesizes why superheavy elements last longer than predicted.[47] Oganesson is radioactive and has a half-life that appears to be less than a millisecond. Nonetheless, this is still longer than some predicted values,[31][48] thus giving further support to the idea of this "island of stability".[49]

Calculations using a quantum-tunneling model predict the existence of several neutron-rich isotopes of oganesson with alpha-decay half-lives close to 1 ms.[50][51]

Theoretical calculations done on the synthetic pathways for, and the half-life of, other isotopes have shown that some could be slightly more stable than the synthesized isotope ^{294}Og, most likely ^{293}Og, ^{295}Og, ^{296}Og, ^{297}Og, ^{298}Og, ^{300}Og and ^{302}Og.[31][52] Of these, ^{297}Og might provide the best chances for obtaining longer-lived nuclei,[31][52] and thus might become the focus of future work with this element. Some isotopes with many more neutrons, such as some located around ^{313}Og could also provide longer-lived nuclei.[53]

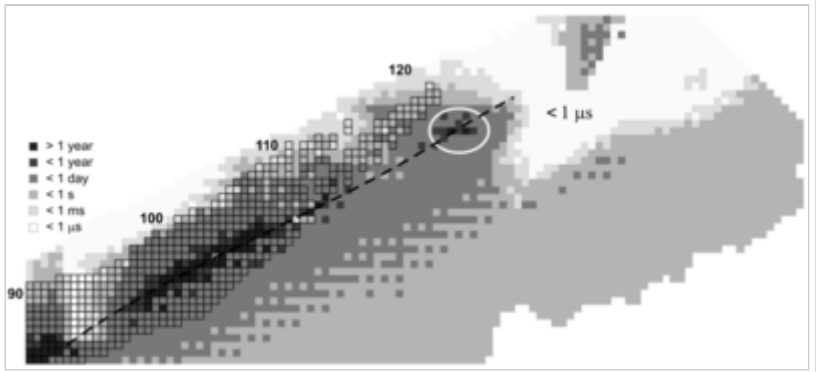
Calculated atomic and physical properties

Oganesson is a member of group 18, the zero-valence elements. The members of this group are usually inert to most common chemical reactions (for example, combustion) because the outer valence shell is completely filled with eight electrons. This produces a stable, minimum energy configuration in which the outer electrons are tightly bound.[54] It is thought that similarly, oganesson has a closed outer valence shell in which its valence electrons are arranged in a $7s^2 7p^6$ configuration.[1]

	(predicted)
Ionization energies	1st: 839.4 kJ/mol *(predicted)*[2] 2nd: 1563.1 kJ/mol *(predicted)*[7]
Covalent radius	157 pm *(predicted)*[8]
	Miscellanea
CAS Number	54144-19-3
	History
Naming	after Yuri Oganessian
Prediction	Niels Bohr (1922)
Discovery	Joint Institute for Nuclear Research and Lawrence Livermore National Laboratory (2002)

Most stable isotopes of oganesson

iso	NA	half-life	DM	DE (MeV)	DP
^{294}Og[9]	syn	~0.89 ms	α	11.65±0.06	^{290}Lv
			SF		



Oganesson (row 118) is slightly above the "island of stability" (white circle) and thus its nuclei are slightly more stable than otherwise predicted.

Consequently, some expect oganesson to have similar physical and chemical properties to other members of its group, most closely resembling the noble gas above it in the periodic table, radon.[55] Following the periodic trend, oganesson would be expected to be slightly more reactive than radon. However, theoretical calculations have shown that it could be quite reactive, so that it probably cannot be considered a noble gas.[6] In addition to being far more reactive than radon, oganesson may be even more reactive than elements flerovium and copernicium.[1] The reason for the apparent enhancement of the chemical activity of oganesson relative to radon is an energetic destabilization and a radial expansion of the last occupied 7p-subshell.[1][a] More precisely, considerable spin–orbit interactions between the 7p electrons and the inert $7s^2$ electrons effectively lead to a second valence shell closing at flerovium, and a significant decrease in stabilization of the closed shell of element 118.[1] It has also been calculated that oganesson, unlike the other noble gases, binds an electron with release of energy—or in other words, it exhibits positive electron affinity,[56][57][b] due to the relativistically stabilized 8s energy level.[58]

Oganesson is expected to have by far the broadest polarizability of all elements before it in the periodic table, almost double that of radon.[1] By extrapolating from the other noble gases, it is expected that oganesson has a boiling point between 320 and 380 K.[1] This is very different from the previously estimated values of 263 K[59] or 247 K.[60] Even given the large uncertainties of the calculations, it seems highly unlikely that oganesson would be a gas under standard conditions,[1][c] and as the liquid range of the other gases is very narrow, between 2 and 9 kelvins, this element should be solid at standard conditions. If oganesson forms a gas under standard conditions nevertheless, it would be one of the densest gaseous substances at standard conditions (even if it is monatomic like the other noble gases).

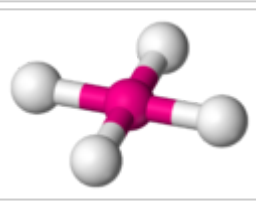
Because of its tremendous polarizability, oganesson is expected to have an anomalously low ionization energy (similar to that of lead which is 70% of that of radon[5] and significantly smaller than that of flerovium[61]) and a standard state condensed phase.[1]

Predicted compounds

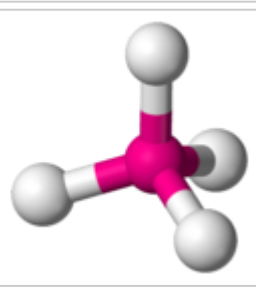
No compounds of oganesson have been synthesized yet, but calculations on theoretical compounds have been performed since 1964.[35] It is expected that if the ionization energy of the element is high enough, it will be difficult to oxidize and therefore, the most common oxidation state will be 0 (as for other noble gases);[62] nevertheless, this appears not to be the case.[7]

Calculations on the diatomic molecule Og_2 showed a bonding interaction roughly equivalent to that calculated for Hg_2, and a dissociation energy of 6 kJ/mol, roughly 4 times of that of Rn_2.[1] But most strikingly, it was calculated to have a bond length shorter than in Rn_2 by 0.16 Å, which would be indicative of a significant bonding interaction.[1] On the other hand, the compound OgH^+ exhibits a dissociation energy (in other words proton affinity of oganesson) that is smaller than that of RnH^+.[1]

The bonding between oganesson and hydrogen in OgH is predicted to be very weak and can be regarded as a pure van der Waals interaction rather than a true chemical bond.[5] On the other hand, with highly electronegative elements, oganesson seems to form more stable compounds than for example copernicium or flerovium.[5] The stable oxidation states +2 and +4 have been predicted to exist in the fluorides OgF_2 and OgF_4.[63] The +6 state would be less stable due to the strong binding of the $7p_{1/2}$ subshell.[7] This is a result of the same spin-orbit interactions that make oganesson unusually reactive. For example, it was shown that the reaction of oganesson with F_2 to form the compound OgF_2 would release an energy of 106 kcal/mol of which about 46 kcal/mol come from these interactions.[5] For comparison, the spin-orbit interaction for the similar molecule RnF_2 is about 10 kcal/mol out of a formation energy of 49 kcal/mol.[5] The same interaction stabilizes the tetrahedral T_d configuration for OgF_4, as distinct from the square planar D_{4h} one of XeF_4, which RnF_4 is also expected to have.[63] The Og–F bond will most probably be ionic rather than covalent, rendering the oganesson fluorides non-volatile.[6][64] OgF_2 is predicted to be partially ionic due to oganesson's high electropositivity.[65] Unlike the other noble gases (except possibly xenon and radon),[66][67] oganesson is predicted to be sufficiently electropositive[65] to form an Og–Cl bond with chlorine.[6]



XeF_4 has a square planar configuration.



OgF_4 is predicted to have a tetrahedral configuration.

Source

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