Neodymium

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Neodymium is a chemical element with symbol **Nd** and atomic number 60. It is a soft silvery metal that tarnishes in air. Neodymium was discovered in 1885 by the Austrian chemist Carl Auer von Welsbach. It is present in significant quantities in the ore minerals monazite and bastnäsite. Neodymium is not found naturally in metallic form or unmixed with other lanthanides, and it is usually refined for general use. Although neodymium is classed as a rare earth, it is a fairly common element, no rarer than cobalt, nickel, and copper, and is widely distributed in the Earth's crust.[3] Most of the world's commercial neodymium is mined in China.

Neodymium compounds were first commercially used as glass dyes in 1927, and they remain a popular additive in glasses. The color of neodymium compounds—due to the Nd^{3+} ion—is often a reddish-purple but it changes with the type of lighting, due to the interaction of the sharp light absorption bands of neodymium with ambient light enriched with the sharp visible emission bands of mercury, trivalent europium or terbium. Some neodymium-doped glasses are also used in lasers that emit infrared with wavelengths between 1047 and 1062 nanometers. These have been used in extremely-high-power applications, such as experiments in inertial confinement fusion.

Neodymium is also used with various other substrate crystals, such as yttrium aluminum garnet in the Nd:YAG laser. This laser usually emits infrared at a wavelength of about 1064 nanometers. The Nd:YAG laser is one of the most commonly used solid-state lasers.

Another important use of neodymium is as a component in the alloys used to make high-strength neodymium magnets—powerful permanent magnets.[4] These magnets are widely used in such products as microphones, professional loudspeakers, in-ear headphones, high performance hobby DC electric motors, and computer hard disks, where low magnet mass (or volume) or strong magnetic fields are required. Larger neodymium magnets are used in high-power-versus-weight electric motors (for example in hybrid cars) and generators (for example aircraft and wind turbine electric generators).[5]

Neodymium, $_{60}$Nd

General properties	
Name, symbol	neodymium, Nd
Appearance	silvery white
Neodymium in the periodic table	
Atomic number (Z)	60
Group, block	group n/a, f-block
Period	period 6
Element category	lanthanide
Standard atomic weight (±) (A_r)	144.242(3)[1]
Electron configuration	[Xe] $4f^4$ $6s^2$
per shell	2, 8, 18, 22, 8, 2
Physical properties	
Phase	solid

Characteristics

Physical properties

Neodymium, a rare earth metal, was present in the classical mischmetal at a concentration of about 18%. Metallic neodymium has a bright, silvery metallic luster, but as one of the more reactive lanthanide rare-earth metals, it quickly oxidizes in ordinary air. The oxide layer forms then peels off, exposing the metal to further oxidation. Thus, a centimeter-sized sample of neodymium completely oxidizes within a year.[6]

Neodymium commonly exists in two allotropic forms, with a transformation from a double hexagonal to a body-centered cubic structure taking place at about 863 °C.[7]

Chemical properties

Neodymium metal tarnishes slowly in air and it burns readily at about 150 °C to form neodymium(III) oxide:

$$4\ Nd + 3\ O_2 \rightarrow 2\ Nd_2O_3$$

Neodymium is a quite electropositive element, and it reacts slowly with cold water, but quite quickly with hot water to form neodymium(III) hydroxide:

$$2\ Nd\ (s) + 6\ H_2O\ (l) \rightarrow 2\ Nd(OH)_3\ (aq) + 3\ H_2\ (g)$$

Neodymium metal reacts vigorously with all the halogens:

$$2\ Nd\ (s) + 3\ F_2\ (g) \rightarrow 2\ NdF_3\ (s)$$ [a violet substance]
$$2\ Nd\ (s) + 3\ Cl_2\ (g) \rightarrow 2\ NdCl_3\ (s)$$ [a mauve substance]
$$2\ Nd\ (s) + 3\ Br_2\ (g) \rightarrow 2\ NdBr_3\ (s)$$ [a violet substance]
$$2\ Nd\ (s) + 3\ I_2\ (g) \rightarrow 2\ NdI_3\ (s)$$ [a green substance]

Neodymium dissolves readily in dilute sulfuric acid to form solutions that contain the lilac Nd(III) ion. These exist as a $[Nd(OH_2)_9]^{3+}$ complexes:[8]

Melting point	1297 K (1024 °C, 1875 °F)
Boiling point	3347 K (3074 °C, 5565 °F)
Density near r.t.	7.01 g/cm^3
when liquid, at m.p.	6.89 g/cm^3
Heat of fusion	7.14 kJ/mol
Heat of vaporization	289 kJ/mol
Molar heat capacity	27.45 J/(mol·K)

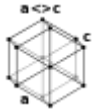
Vapor pressure

P (Pa)	**1**	**10**	**100**	**1 k**	**10 k**	**100 k**
at T (K)	1595	1774	1998	(2296)	(2715)	(3336)

Atomic properties

Oxidation states	+4, **+3**, +2 (a mildly basic oxide)
Electronegativity	Pauling scale: 1.14
Ionization energies	1st: 533.1 kJ/mol 2nd: 1040 kJ/mol 3rd: 2130 kJ/mol
Atomic radius	empirical: 181 pm
Covalent radius	201±6 pm

Miscellanea

Crystal structure	double hexagonal close-packed (dhcp) 
Speed of sound thin rod	2330 m/s (at 20 °C)
Thermal expansion	α, poly: 9.6 µm/(m·K) (at r.t.)
Thermal conductivity	16.5 W/(m·K)

$$2\ Nd\ (s) + 3\ H_2SO_4\ (aq) \rightarrow 2\ Nd^{3+}\ (aq) + 3\ SO_4^{2-}\ (aq) + 3\ H_2\ (g)$$

Compounds

Neodymium compounds include

- halides: neodymium(III) fluoride (NdF_3); neodymium(III) chloride ($NdCl_3$); neodymium(III) bromide ($NdBr_3$); neodymium(III) iodide (NdI_3)
- oxides: neodymium(III) oxide (Nd_2O_3)
- sulfides: neodymium(II) sulfide (NdS), neodymium(III) sulfide (Nd_2S_3)
- nitrides: neodymium(III) nitride (NdN)
- hydroxide: neodymium(III) hydroxide ($Nd(OH)_3$)
- phosphide: neodymium phosphide (NdP)
- carbide: neodymium carbide (NdC_2)
- nitrate: neodymium(III) nitrate ($Nd(NO_3)_3$)
- sulfate: neodymium(III) sulfate ($Nd_2(SO_4)_3$)

Neodymium(III)-sulfate

Electrical resistivity	α, poly: 643 nΩ·m
Magnetic ordering	paramagnetic, antiferromagnetic below 20 K[2]
Young's modulus	α form: 41.4 GPa
Shear modulus	α form: 16.3 GPa
Bulk modulus	α form: 31.8 GPa
Poisson ratio	α form: 0.281
Vickers hardness	345–745 MPa
Brinell hardness	265–700 MPa
CAS Number	7440-00-8
History	
Discovery	Carl Auer von Welsbach (1885)

Most stable isotopes of neodymium

iso	NA	half-life	DM	DE (MeV)	DP
^{142}Nd	27.2%	is stable with 82 neutrons			
^{143}Nd	12.2%	is stable with 83 neutrons			
^{144}Nd	23.8%	2.29×10^{15} y	α	1.905	^{140}Ce
^{145}Nd	8.3%	is stable with 85 neutrons			
^{146}Nd	17.2%	is stable with 86 neutrons			
^{148}Nd	5.8%	is stable with 88 neutrons			
^{150}Nd	5.6%	6.7×10^{18} y	$\beta^-\beta^-$	3.367	^{150}Sm

Isotopes

Naturally occurring neodymium is a mixture of five stable isotopes, ^{142}Nd, ^{143}Nd, ^{145}Nd, ^{146}Nd and ^{148}Nd, with ^{142}Nd being the most abundant (27.2% of the natural abundance), and two radioisotopes, ^{144}Nd and ^{150}Nd. In all, 31 radioisotopes of neodymium have been detected as of 2010, with the most stable radioisotopes being the naturally occurring ones: ^{144}Nd (alpha decay with a half-life ($t_{1/2}$) of 2.29×10^{15} years) and ^{150}Nd (double beta decay, $t_{1/2}$ =

7×10^{18} years, approximately). All of the remaining radioactive isotopes have half-lives that are shorter than eleven days, and the majority of these have half-lives that are shorter than 70 seconds. Neodymium also has 13 known meta states, with the most stable one being ^{139m}Nd ($t_{1/2}$ = 5.5 hours), ^{135m}Nd ($t_{1/2}$ = 5.5 minutes) and ^{133m1}Nd ($t_{1/2}$ ~70 seconds).

The primary decay modes before the most abundant stable isotope, ^{142}Nd, are electron capture and positron decay, and the primary mode after is beta minus decay. The primary decay products before ^{142}Nd are element Pr (praseodymium) isotopes and the primary products after are element Pm (promethium) isotopes.

Source

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