

CHEM-E4130

# Neodymium(Nd)

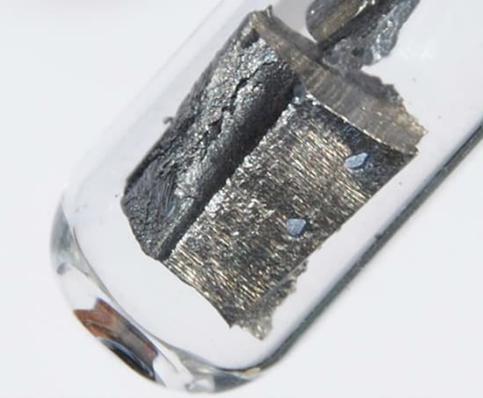
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7.Oct.2022



Aalto University





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- Element
- Chemistry
- Compounds
- Applications

**Element**

**History of Neodymium**



### **Origin of its Name:**

The name of the element is derived from the Greek word “neos didymos” meaning new twin

### **Who discovered Nd:**

1885 by Carl Auer von Welsbach

### **Where is Neodymium found?**

Historically, a single mine in California produced most of the world’s rare earth minerals, but since the early 90s, China has become the world’s primary source.

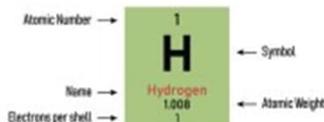


# Element

What is **Neodymium**

# Periodic Table of the Elements

1 IA 1 <b>H</b> Hydrogen 1.008 1																	18 VIIIA 2 <b>He</b> Helium 4.0026 2	
3 <b>Li</b> Lithium 6.941 2.1	4 <b>Be</b> Beryllium 9.0122 1.9																	10 <b>Ne</b> Neon 20.180 2.0
11 <b>Na</b> Sodium 22.98976928 2.81	12 <b>Mg</b> Magnesium 24.305 2.82																	18 <b>Ar</b> Argon 39.948 2.83
19 <b>K</b> Potassium 39.0983 2.841	20 <b>Ca</b> Calcium 40.078 2.842	21 <b>Sc</b> Scandium 44.955910 2.85-2	22 <b>Ti</b> Titanium 47.88 2.85-2	23 <b>V</b> Vanadium 50.9415 2.85-2	24 <b>Cr</b> Chromium 51.9961 2.85-2	25 <b>Mn</b> Manganese 54.938044 2.85-2	26 <b>Fe</b> Iron 55.845 2.85-2	27 <b>Co</b> Cobalt 58.933 2.85-2	28 <b>Ni</b> Nickel 58.693 2.85-2	29 <b>Cu</b> Copper 63.546 2.85-2	30 <b>Zn</b> Zinc 65.38 2.85-2	31 <b>Ga</b> Gallium 69.723 2.85-2	32 <b>Ge</b> Germanium 72.630 2.85-2	33 <b>As</b> Arsenic 74.9216 2.85-2	34 <b>Se</b> Selenium 78.9718 2.85-2	35 <b>Br</b> Bromine 79.904 2.85-2	36 <b>Kr</b> Krypton 83.798 2.85-2	
37 <b>Rb</b> Rubidium 85.4678 2.85-2	38 <b>Sr</b> Strontium 87.62 2.85-2	39 <b>Y</b> Yttrium 88.90584 2.85-2	40 <b>Zr</b> Zirconium 91.224 2.85-2	41 <b>Nb</b> Niobium 92.90637 2.85-2	42 <b>Mo</b> Molybdenum 95.95 2.85-2	43 <b>Tc</b> Technetium 98 2.85-2	44 <b>Ru</b> Ruthenium 101.07 2.85-2	45 <b>Rh</b> Rhodium 102.91 2.85-2	46 <b>Pd</b> Palladium 106.42 2.85-2	47 <b>Ag</b> Silver 107.87 2.85-2	48 <b>Cd</b> Cadmium 112.41 2.85-2	49 <b>In</b> Indium 114.82 2.85-2	50 <b>Sn</b> Tin 118.71 2.85-2	51 <b>Sb</b> Antimony 121.76 2.85-2	52 <b>Te</b> Tellurium 127.60 2.85-2	53 <b>I</b> Iodine 126.905 2.85-2	54 <b>Xe</b> Xenon 131.29 2.85-2	
55 <b>Cs</b> Cesium 132.90545196 2.85-2	56 <b>Ba</b> Barium 137.33 2.85-2	57-71 Lanthanides	72 <b>Hf</b> Hafnium 178.49 2.85-2	73 <b>Ta</b> Tantalum 180.94788 2.85-2	74 <b>W</b> Tungsten 183.84 2.85-2	75 <b>Re</b> Rhenium 186.21 2.85-2	76 <b>Os</b> Osmium 190.23 2.85-2	77 <b>Ir</b> Iridium 192.22 2.85-2	78 <b>Pt</b> Platinum 195.08 2.85-2	79 <b>Au</b> Gold 196.967 2.85-2	80 <b>Hg</b> Mercury 200.59 2.85-2	81 <b>Tl</b> Thallium 204.38 2.85-2	82 <b>Pb</b> Lead 207.2 2.85-2	83 <b>Bi</b> Bismuth 208.98 2.85-2	84 <b>Po</b> Polonium 209 2.85-2	85 <b>At</b> Astatine 210 2.85-2	86 <b>Rn</b> Radon 222 2.85-2	
87 <b>Fr</b> Francium 223 2.85-2	88 <b>Ra</b> Radium 226 2.85-2	89-103 Actinides	104 <b>Rf</b> Rutherfordium 261 2.85-2	105 <b>Db</b> Dubnium 262 2.85-2	106 <b>Sg</b> Seaborgium 263 2.85-2	107 <b>Bh</b> Bohrium 264 2.85-2	108 <b>Hs</b> Hassium 265 2.85-2	109 <b>Mt</b> Meitnerium 266 2.85-2	110 <b>Ds</b> Darmstadtium 268 2.85-2	111 <b>Rg</b> Roentgenium 269 2.85-2	112 <b>Cn</b> Copernicium 277 2.85-2	113 <b>Nh</b> Nihonium 278 2.85-2	114 <b>Fl</b> Flerovium 279 2.85-2	115 <b>Mc</b> Moscovium 281 2.85-2	116 <b>Lv</b> Livermorium 283 2.85-2	117 <b>Ts</b> Tennessine 284 2.85-2	118 <b>Og</b> Oganesson 284 2.85-2	



State of matter (color of name)  
GAS LIQUID SOLID UNKNOWN

Subcategory in the metal-metalloid-nonmetal trend (color of background)

- Alkali metals
- Lanthanides
- Metalloids
- Unknown chemical properties
- Alkaline earth metals
- Actinides
- Reactive nonmetals
- Transition metals
- Post-transition metals
- Noble gases

57 <b>La</b> Lanthanum 138.905 2.85-2	58 <b>Ce</b> Cerium 140.12 2.85-2	59 <b>Pr</b> Praseodymium 140.907 2.85-2	60 <b>Nd</b> Neodymium 144.24 2.85-2	61 <b>Pm</b> Promethium 145 2.85-2	62 <b>Sm</b> Samarium 150.36 2.85-2	63 <b>Eu</b> Europium 151.964 2.85-2	64 <b>Gd</b> Gadolinium 157.25 2.85-2	65 <b>Tb</b> Terbium 158.925 2.85-2	66 <b>Dy</b> Dysprosium 162.50 2.85-2	67 <b>Ho</b> Holmium 164.930 2.85-2	68 <b>Er</b> Erbium 167.257 2.85-2	69 <b>Tm</b> Thulium 168.934 2.85-2	70 <b>Yb</b> Ytterbium 173.054 2.85-2	71 <b>Lu</b> Lutetium 174.967 2.85-2
89 <b>Ac</b> Actinium 227 2.85-2	90 <b>Th</b> Thorium 232.0377 2.85-2	91 <b>Pa</b> Protactinium 231.036 2.85-2	92 <b>U</b> Uranium 238.02891 2.85-2	93 <b>Np</b> Neptunium 237.04817 2.85-2	94 <b>Pu</b> Plutonium 244.0642 2.85-2	95 <b>Am</b> Americium 243.0613 2.85-2	96 <b>Cm</b> Curium 247.0754 2.85-2	97 <b>Bk</b> Berkelium 247.0713 2.85-2	98 <b>Cf</b> Californium 251.0832 2.85-2	99 <b>Es</b> Einsteinium 252.0832 2.85-2	100 <b>Fm</b> Fermium 257.1037 2.85-2	101 <b>Md</b> Mendelevium 258.1037 2.85-2	102 <b>No</b> Nobelium 259.1037 2.85-2	103 <b>Lr</b> Lawrencium 260.1037 2.85-2



ChemistryLearner.com

- **Atomic number: 60**
- **$[\text{Xe}] 4f^4 6s^2$**
- **Atomic weight: 144.243**
- **Lanthanides (f-block)**
- One of the rare-earth metals
- Melting point: 21 °C
- Boiling point: 3,074 °C

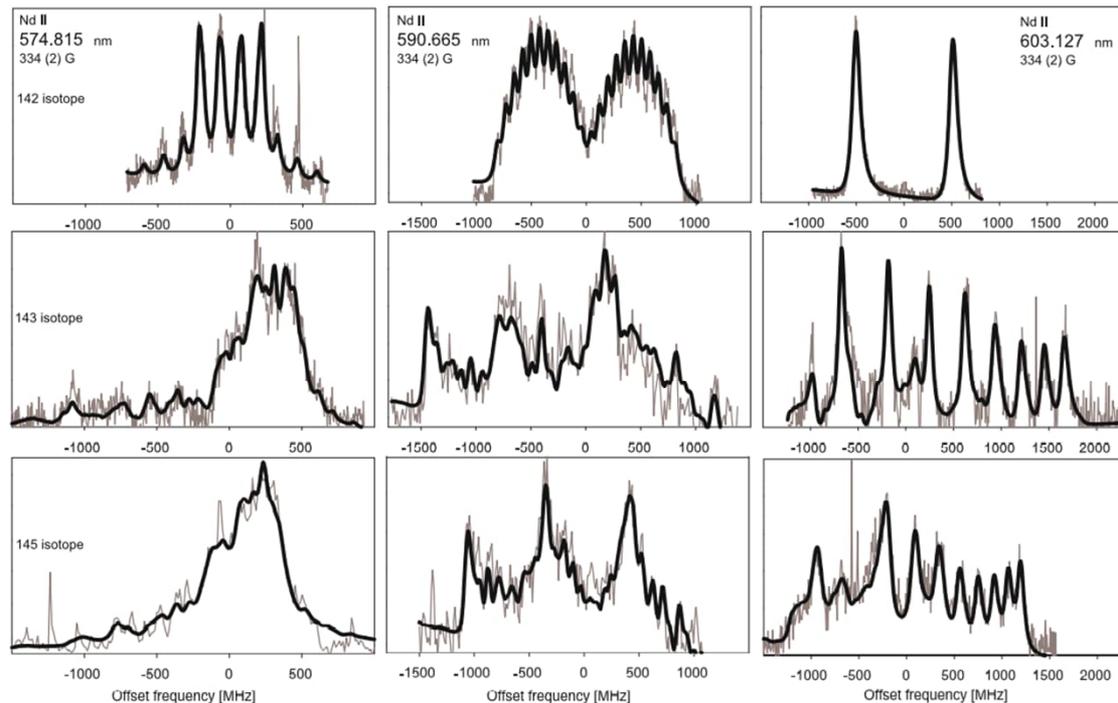
# Chemistry

**Properties and specifics of**

**Neodymium**

# Chemistry

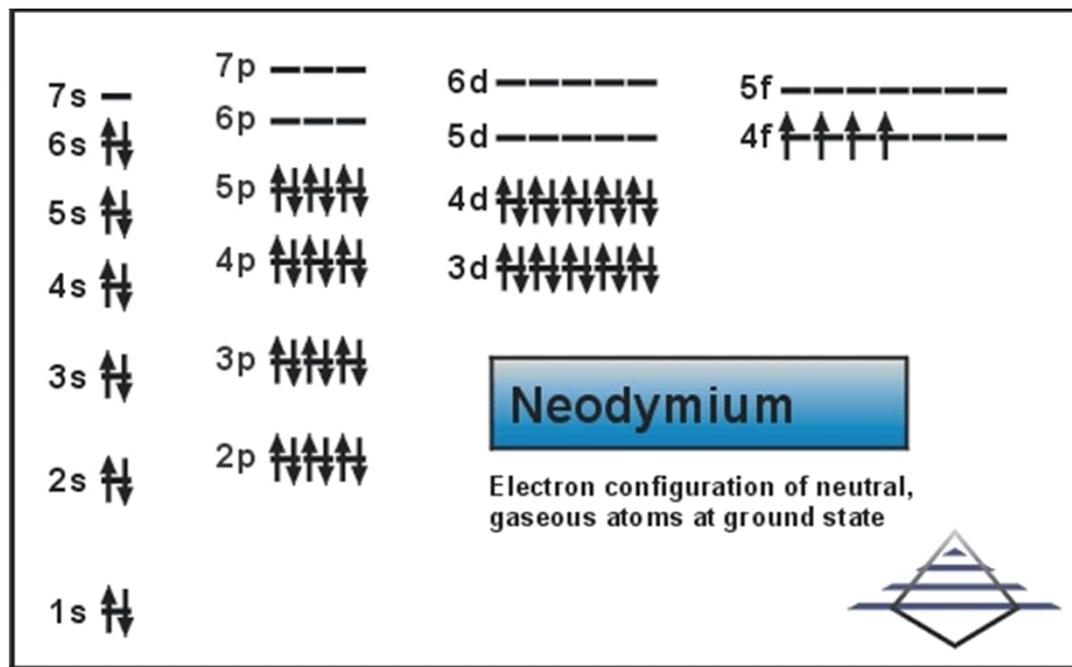
## laser spectroscopy of Nd(II)



## general info

Classification:	Neodymium is a lanthanide and rare earth metal
Color:	silvery-white
Atomic weight:	144.24
State:	solid
Melting point:	1016 °C, 1289 K
Boiling point:	3070 °C, 3343 K
Electrons:	60
Protons:	60
Neutrons in most abundant isotope:	82
Electron shells:	2,8,18,22,8,2
Electron configuration:	[Xe] 4f <sup>4</sup> 6s <sup>2</sup>
Density @ 20°C:	7.0 g/cm <sup>3</sup>

Crystal structure	hexagonal
Oxidation states	3 (mildly basic oxide)
Electronegativity	1.14 (Pauling scale)
Ionization energies (more)	1st: 533.1 kJ·mol <sup>-1</sup>
	2nd: 1040 kJ·mol <sup>-1</sup>
	3rd: 2130 kJ·mol <sup>-1</sup>
Atomic radius	185 pm
Atomic radius (calc.)	206 pm
Magnetic ordering	ferromagnetic
Electrical resistivity	(r.t.) (α, poly) 643 nΩ·m
Thermal conductivity	(300 K) 16.5 W·m <sup>-1</sup> ·K <sup>-1</sup>
Thermal expansion	(r.t.) (α, poly) 9.6 μm/(m·K)
Speed of sound (thin rod)	(20 °C) 2330 m/s
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



# Compounds

Examples of **Neodymium**  
compounds

# Compounds



- Used to dope glass
- Nd's sharp absorption bands cause the color change under different lighting conditions
- Purple in daylight, blue under fluorescent and greenish under trichromatic



[https://commons.wikimedia.org/wiki/File:Neodymium\\_glass\\_light\\_bulb\\_under\\_fluorescent\\_and\\_incandescent\\_light.jpg](https://commons.wikimedia.org/wiki/File:Neodymium_glass_light_bulb_under_fluorescent_and_incandescent_light.jpg)



- An important intermediate in mineral processing
- Organic catalysis
- Nd-YAG laser



bastnäsite

<https://en.wikipedia.org/wiki/File:Basstnasite-155010.jpg>



- Also an intermediate in mineral processing, especially bastnäsite and parisite



parisite

<https://commons.wikimedia.org/wiki/File:Parisite-39471.jpg>



- Lasers and glass doping

Other noteworthy

- $\text{Nd}(\text{OH})_3$
- $\text{Nd}(\text{CH}_3\text{COO})_3$
- $\text{NdCl}_2$
- $\text{NdBr}_3$
- $\text{NdI}_2$
- $\text{NdI}_3$



$\text{Nd}_2(\text{SO}_4)_3$

[https://commons.wikimedia.org/wiki/File:Neodymium\(III\)sulfat.JPG](https://commons.wikimedia.org/wiki/File:Neodymium(III)sulfat.JPG)

# Applications

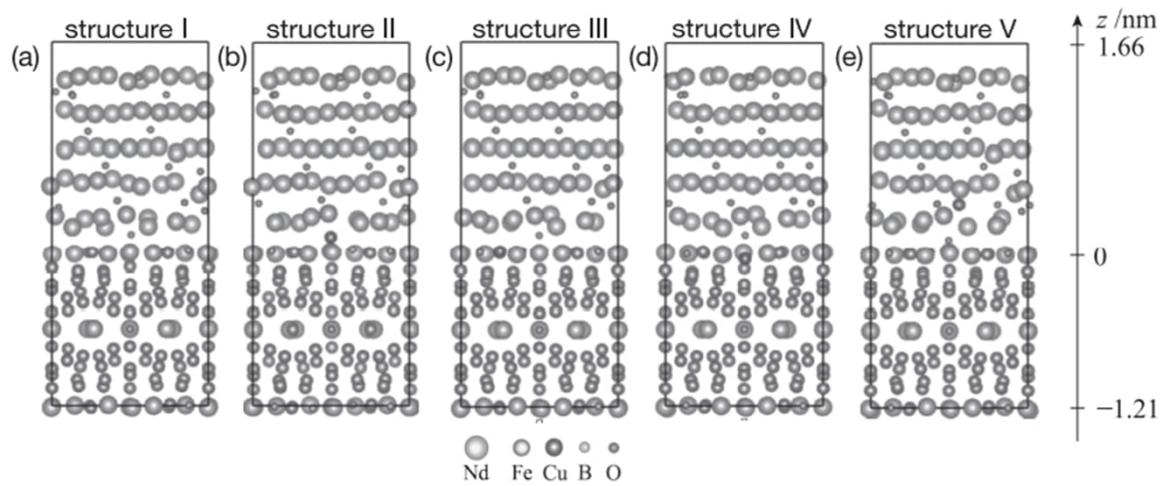
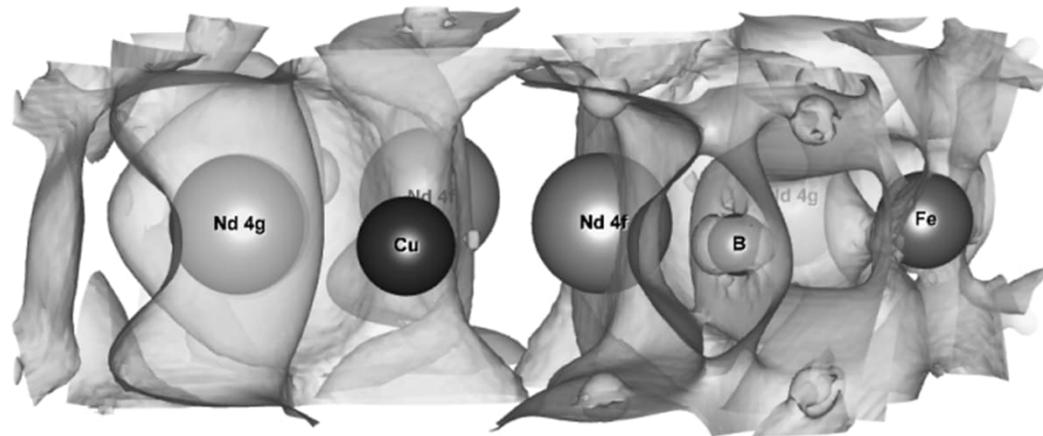
- Neodymium supermagnets
- Electron microscopy

# Neodymium magnets

- New applications for Nd magnets are in wind power generators and electric car engines
- The high temperatures in such environments require further development of materials
- Improvement is possible by optimizing surface local magnetic sites in Nd-Fe-B magnets



Yoshihiro Gohda et. al, Electron Theory on Grain-Boundary Structures and Local Magnetic Properties of Neodymium Magnets, MATERIALS TRANSACTIONS, 2018, Volume 59, Issue 3, Pages 332-337, J-STAGE February 25, 2018, ISSN 1347-5320, Print ISSN 1345-9678, <https://doi.org/10.2320/matertrans.M2017258>



# Nd as an alternative for uranium in electron microscopy

- Uranyl acetate is the most commonly used contrasting agent in electron microscopy in biochemistry
- Uranyl ions bind to phosphate and amino groups in proteins and lipids
- Heavy elements are more electron rich and appear darker in electron microscopy



Uranyl acetate  
 $\text{UO}_2(\text{CH}_3\text{CO}_2)_2 \cdot (\text{H}_2\text{O}) \cdot \text{H}_2\text{O}$

[https://en.wikipedia.org/wiki/File:Uranyl\\_Acetate\\_10\\_3\\_07.jpg](https://en.wikipedia.org/wiki/File:Uranyl_Acetate_10_3_07.jpg)



**Thank you for listening!**

QUESTIONS?