CHEM-E4130

Neodymium(Nd)

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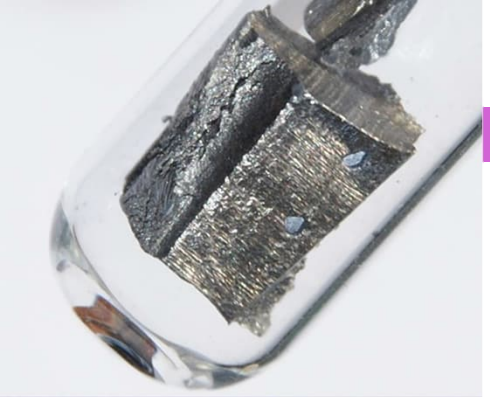


Content

- 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

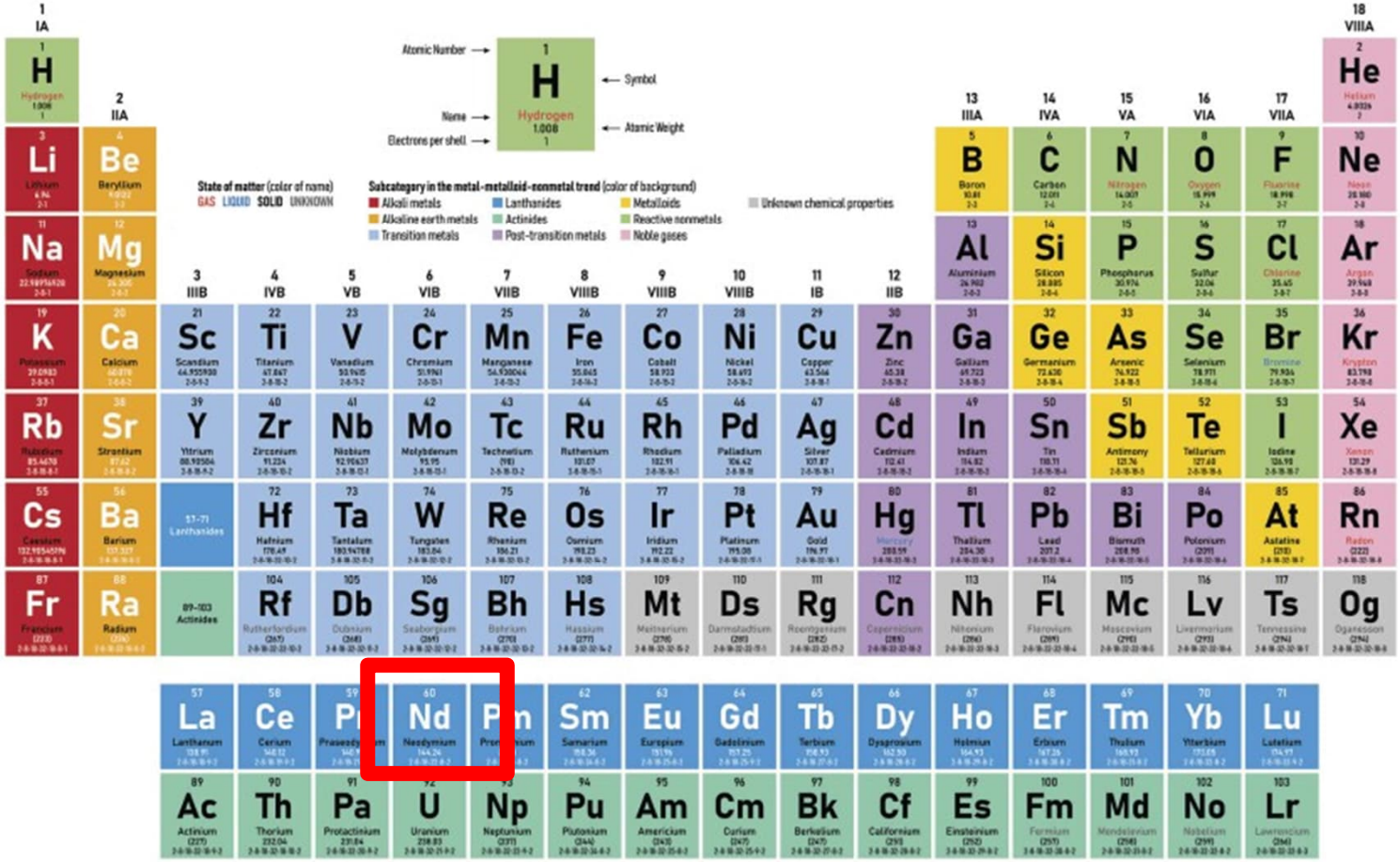
Where is Neodymium found?

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



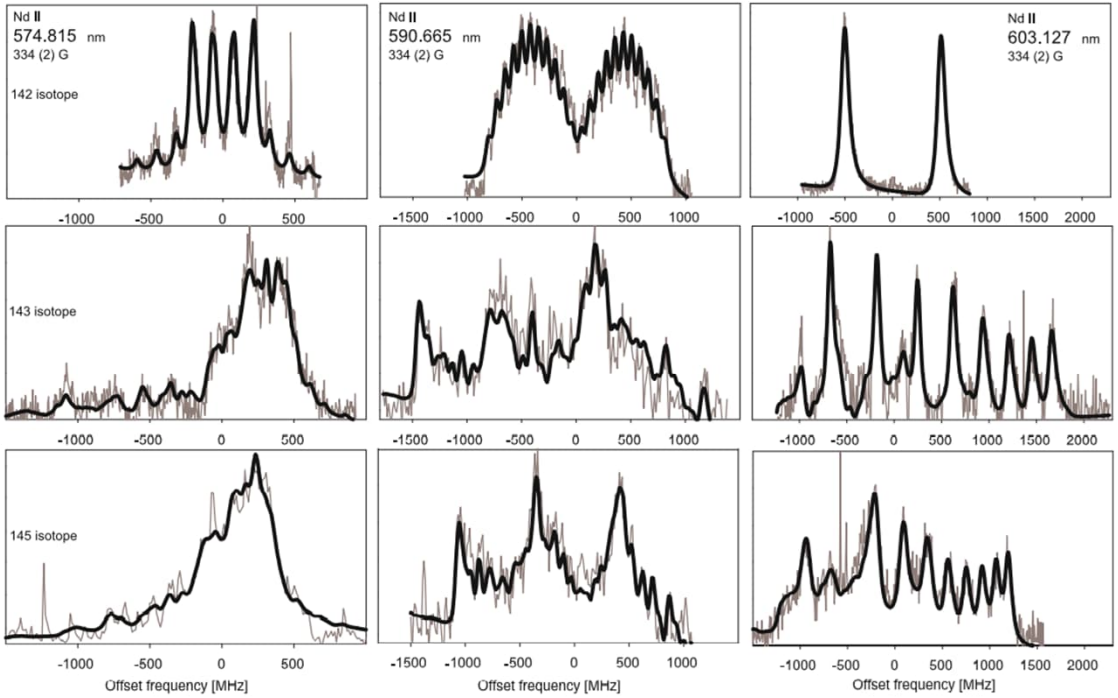
- **Atomic number: 60**
- **[Xe] 4f4 6s2**
- **Atomic weight: 144.243**
- **Lanthanides (f-block)**
- One of the rare-earth metals
- Melting point: 21 °C
- Boiling point:3,074 °C

Chemistry

Properties and specifics of Neodymium

Chemistry

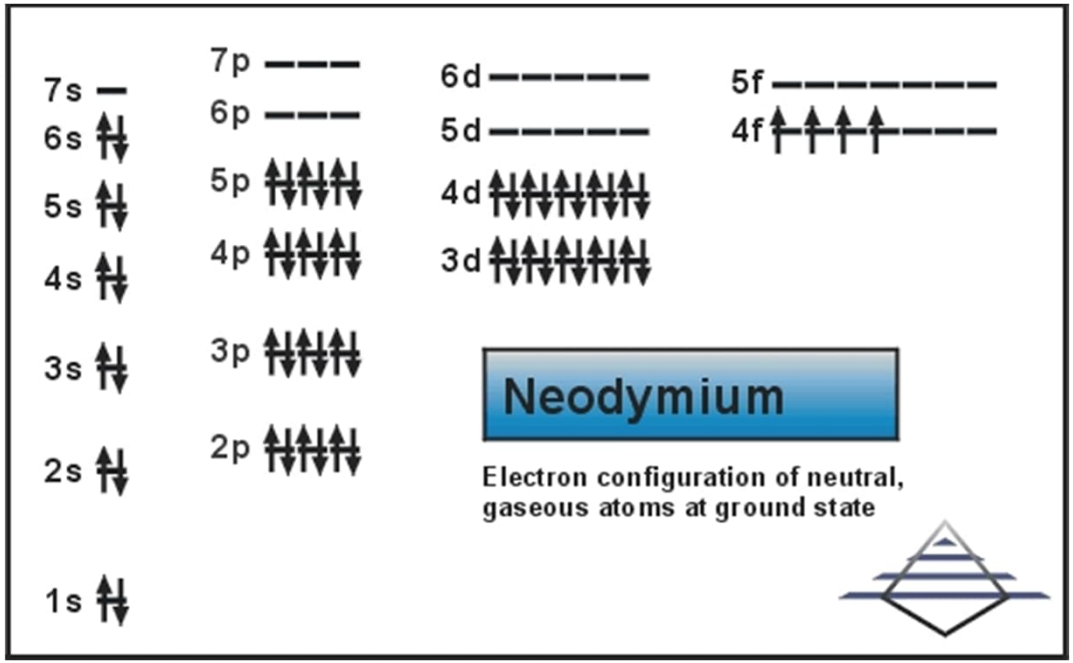
laser spectroscopy of Nd(II)



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] $4f^4\ 6s^2$
Density @ 20°C:	7.0 g/cm^3

Crystal structure	hexagonal
Oxidation states	3 (mildly basic oxide)
Electronegativity	1.14 (Pauling scale)
Ionization energies (more)	1st: 533.1 kJ·mol^{-1}
	2nd: 1040 kJ·mol^{-1}
	3rd: 2130 kJ·mol^{-1}
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^{-1}·K^{-1}
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

Nd_2O_3

- 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

$NdCl_3$

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

bastnäsite

https://en.wikipedia.org/wiki/File:Bastnasite-155010.jpg

NdF_3

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

parisite

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

$Nd_2(CO_3)_3$& $Nd_2(SO_4)_3$

- Lasers and glass doping

Other noteworthy

- $Nd(OH)_3$
- $Nd(CH_3COO)_3$
- $NdCl_2$
- $NdBr_3$
- NdI_2
- NdI_3

$Nd_2(SO_4)_3$

https://commons.wikimedia.org/wiki/File:Neodym(III)sulfat.JPG

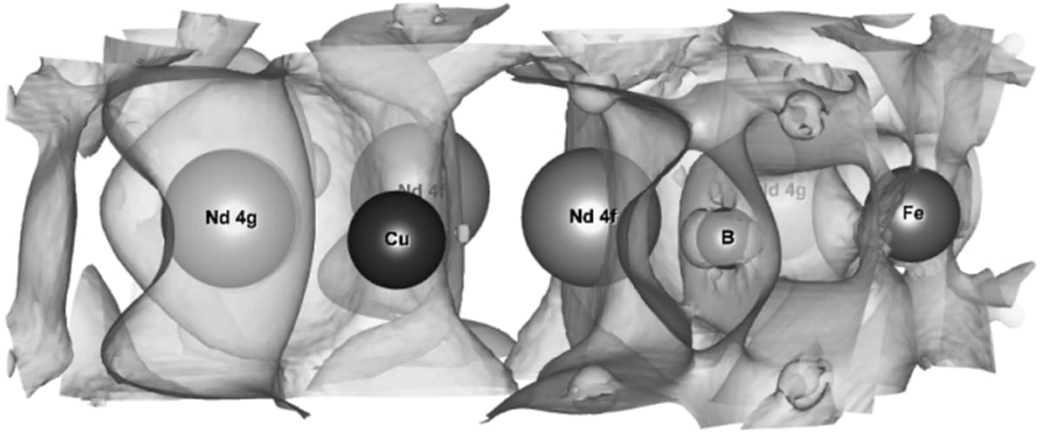
Applications

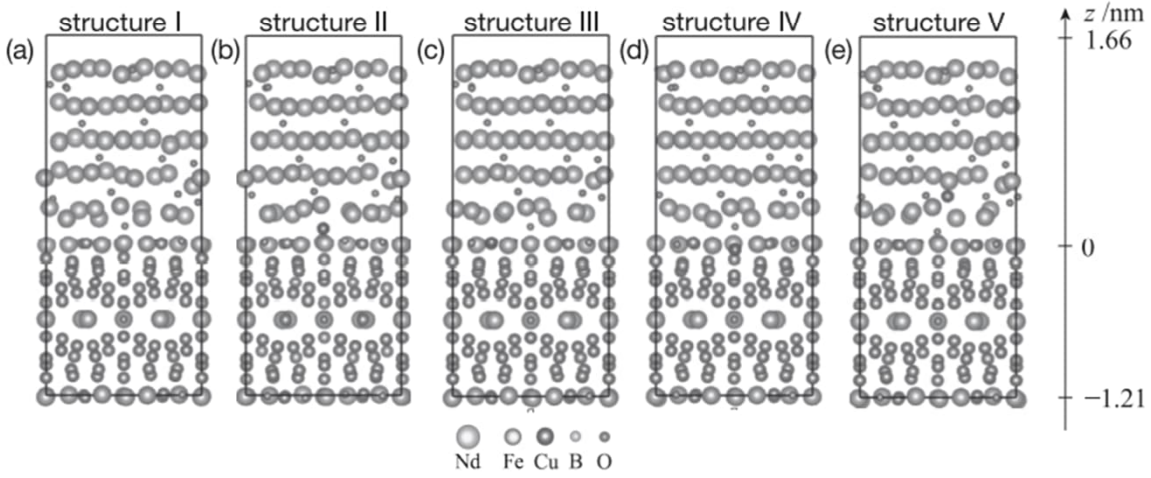
- Neodymium supermagnets
- Electron microscopy

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 4g
Cu
Nd 4f
B
Fe


structure I
structure II
structure III
structure IV
structure V
(a)
(b)
(c)
(d)
(e)
z /nm
1.66
0
−1.21
Nd Fe Cu B O

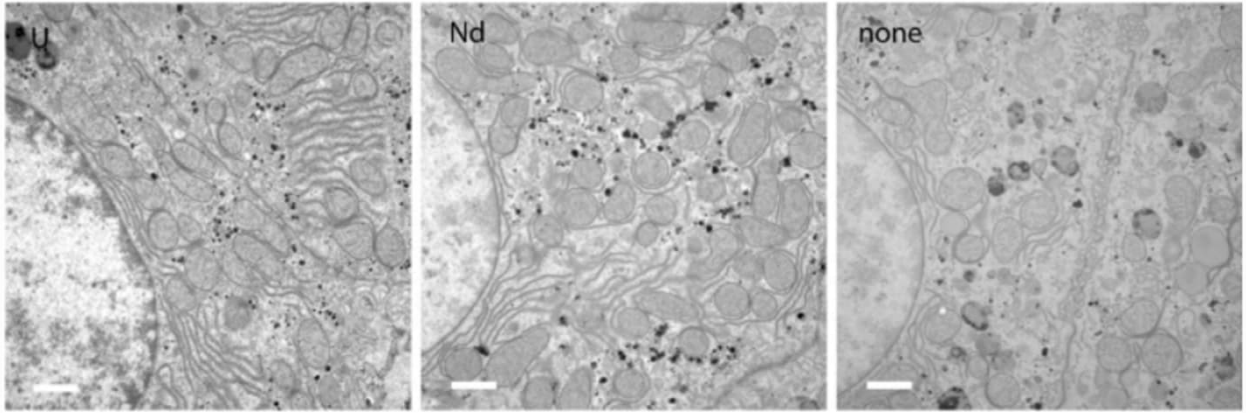
Nd as an alternative for uranium in electron microscopy

- 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

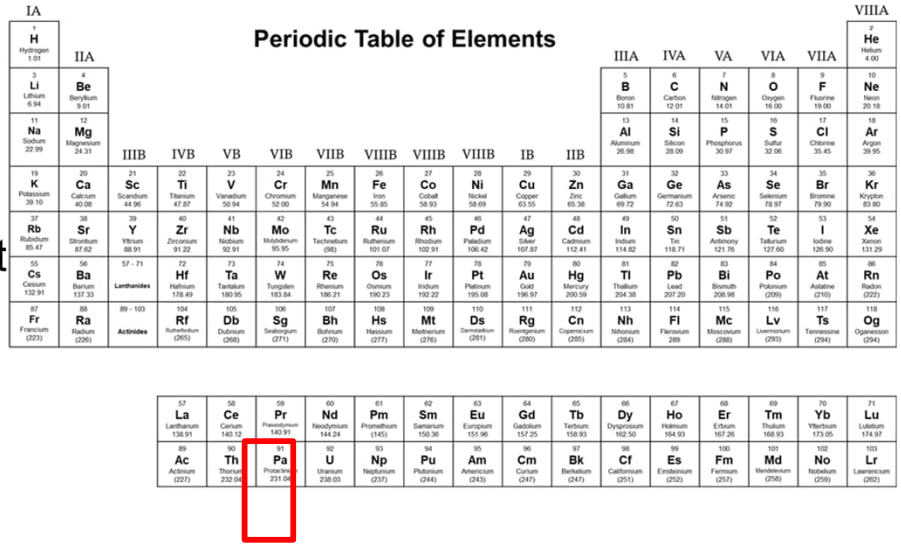
Uranyl acetate
$UO_2(CH_3CO_2)_2(H_2O)\cdot H_2O$

https://en.wikipedia.org/wiki/File:Uranyl_Acetate_10_3_07.jpg

Kuipers, J., Giepmans, B.N.G. Neodymium as an alternative contrast for uranium in electron microscopy. *Histochem Cell Biol* 153, 271–277 (2020). https://doi.org/10.1007/s00418-020-01846-0



- Radioactivity is tolerable while external to the body (14-19 kBq/g), but both chemical toxicity and radioactivity make it very harmful inside the body
- Nd seems like a no-brainer, so why isn't it used?
  - solubility problems
  - availability
  - old habits die hard



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Thank you for listening!

QUESTIONS?