

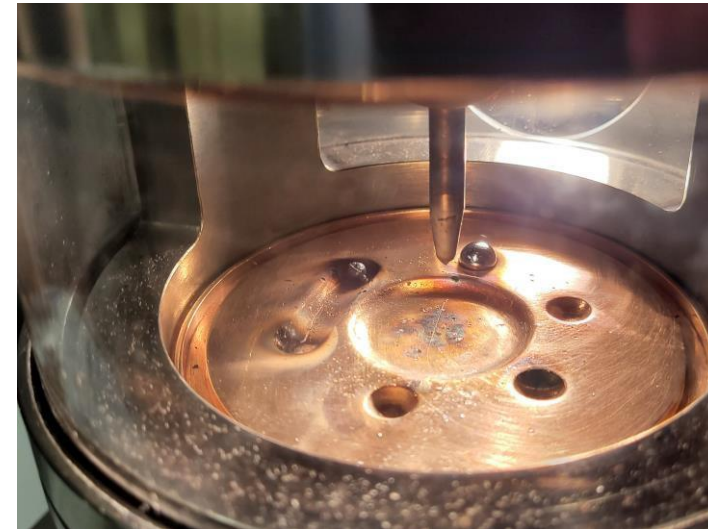
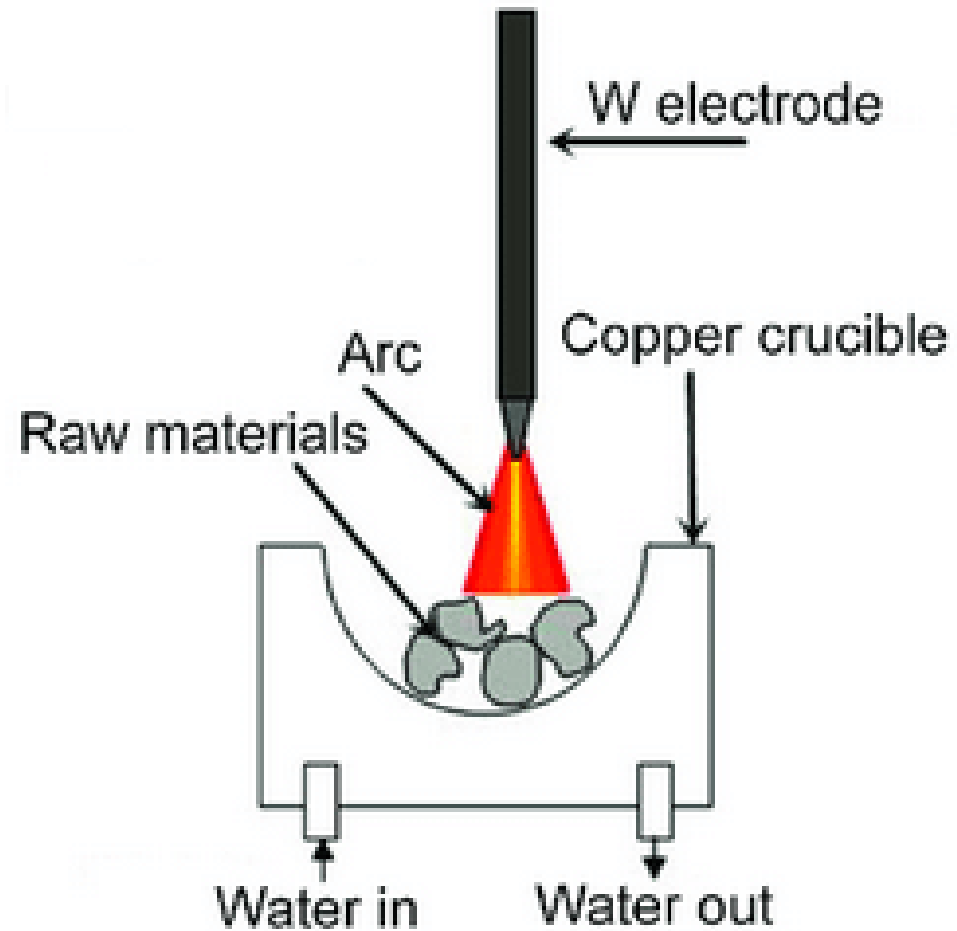
# Magnetic properties of chemically-tuned nickel compounds

Henry Pires-Tolson

## NLST

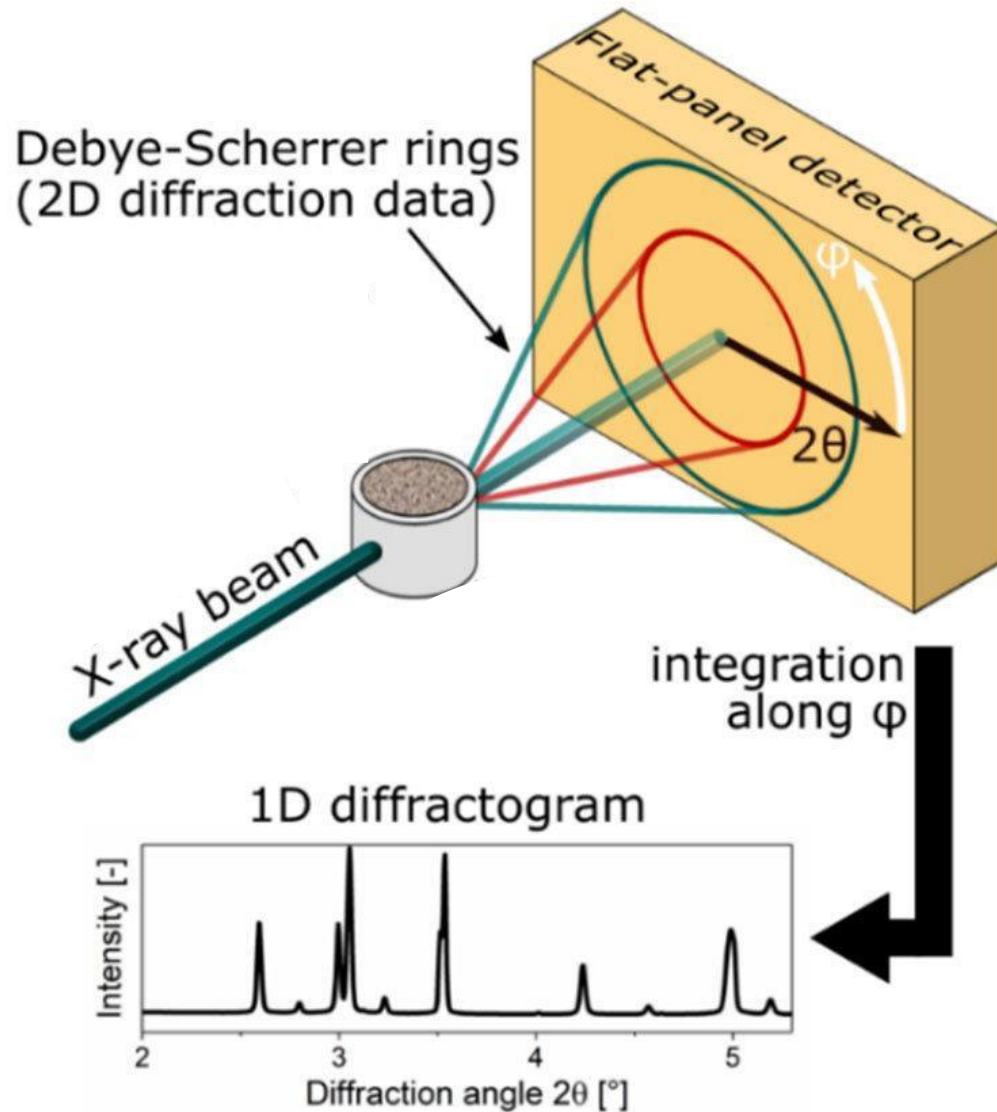
- Nickel is one of the few elemental metals to display ferromagnetic order
- Chemically modifying it can vary its magnetic properties

# Synthesis Method: Electric Single Arc Furnace



Credit: [https://www.researchgate.net/figure/Figure-S2-Schematic-diagram-of-the-vacuum-arc-melting-furnace-with-non-consumable\\_fig9\\_336984599](https://www.researchgate.net/figure/Figure-S2-Schematic-diagram-of-the-vacuum-arc-melting-furnace-with-non-consumable_fig9_336984599)

# Analysis Method: Powder X-ray Diffraction

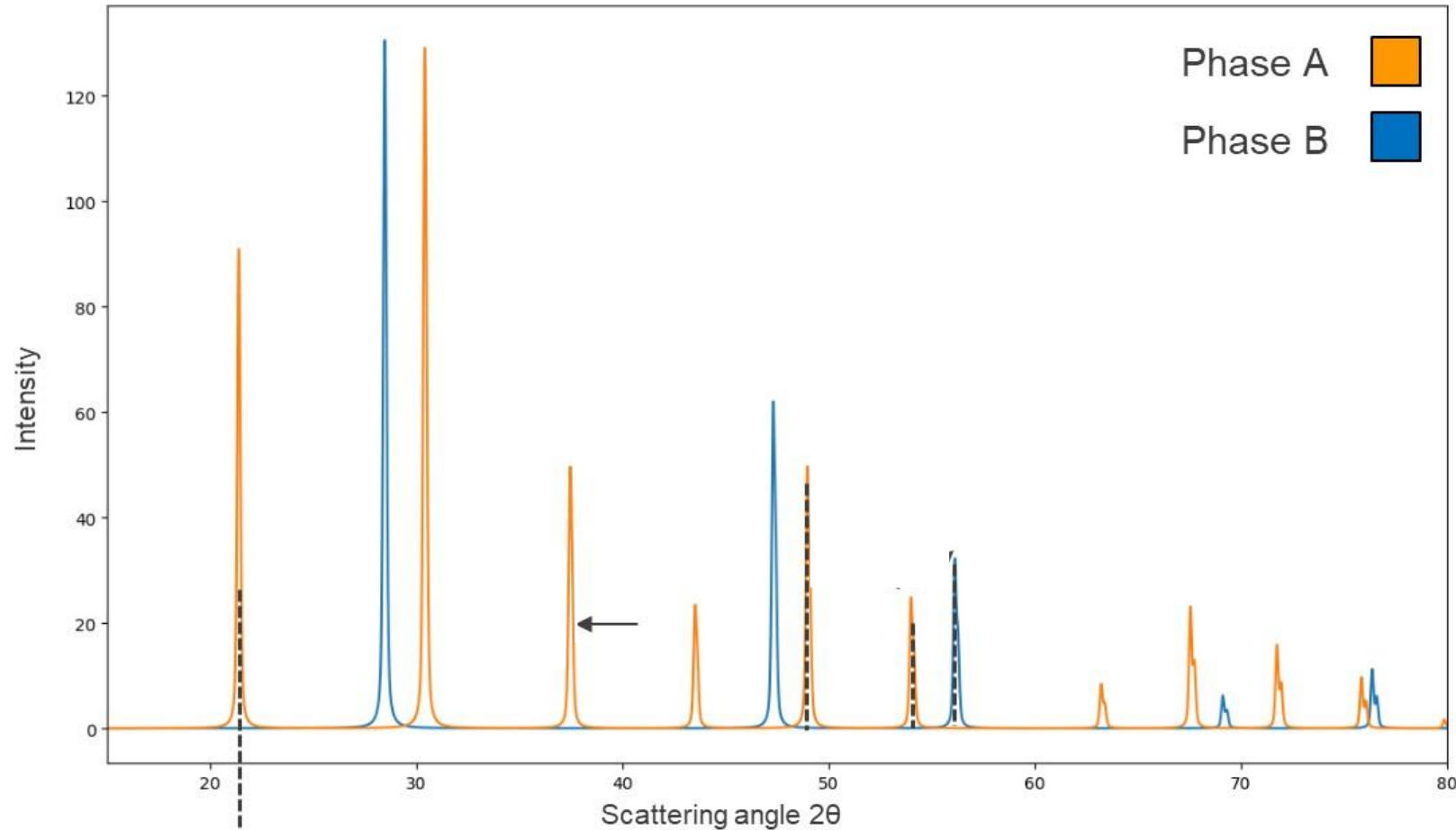


The distance between atoms,  $d$ , is related to the x-ray diffraction pattern by Bragg's Law:  $n\lambda = 2d \sin \theta$



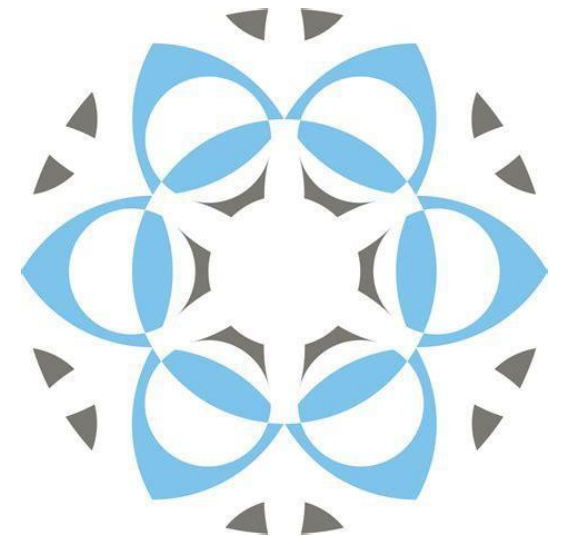


# Analysis Method: Phase Identification



Peak position = material, phase

Credit: <https://wiki.anton-paar.com/en/x-ray-diffraction-xrd/>



Profex

# Scandium-Nickel Compounds w/ Yttrium Substitution

Scandium is doped with yttrium since they are in the same periodic group (column in the periodic table).

Investigated or Investigating:

- $\text{ScNi}_2$
- $\text{Sc}_2\text{Ni}_7$

1

IA

1A

1

H

Hydrogen

1.008

2

IIA

2A

2

He

Helium

4.003

3

Li

Lithium

6.941

4

Be

Beryllium

9.012

11

Na

Sodium

22.990

12

Mg

Magnesium

24.305

19

K

Potassium

39.098

20

Ca

Calcium

40.078

27

Co

Cobalt

58.933

28

Ni

Nickel

58.693

29

Cu

Copper

63.546

30

Zn

Zinc

65.38

37

Rb

Rubidium

85.468

38

Sr

Strontium

87.62

45

Rh

Rhodium

102.906

46

Pd

Palladium

106.42

47

Ag

Silver

107.868

48

Cd

Cadmium

112.414

55

Cs

Cesium

132.905

56

Ba

Barium

137.328

63

Eu

Europium

151.964

64

Gd

Gadolinium

157.25

65

Tb

Terbium

158.925

66

Dy

Dysprosium

162.500

67

Ho

Holmium

164.930

68

Er

Erbium

167.259

69

Tm

Thulium

168.934

70

Yb

Ytterbium

173.055

71

Lu

Lutetium

174.967

5

B

Boron

10.811

6

C

Carbon

12.011

7

N

Nitrogen

14.007

8

O

Oxygen

15.999

9

F

Fluorine

18.998

10

Ne

Neon

20.180

13

Al

Aluminum

26.982

14

Si

Silicon

28.086

15

P

Phosphorus

30.974

16

S

Sulfur

32.065

17

Cl

Chlorine

35.453

18

Ar

Argon

39.948

31

Ga

Gallium

69.723

32

Ge

Germanium

72.631

33

As

Arsenic

74.922

34

Se

Selenium

78.971

35

Br

Bromine

79.904

36

Kr

Krypton

83.798

49

In

Indium

114.818

50

Sn

Tin

118.711

51

Sb

Antimony

121.760

52

Te

Tellurium

127.6

53

I

Iodine

126.904

54

Xe

Xenon

131.294

81

Tl

Thallium

204.383

82

Pb

Lead

207.2

83

Bi

Bismuth

208.980

84

Po

Polonium

[208.982]

85

At

Astatine

208.987

86

Rn

Radon

222.018

89-103

87

Fr

Francium

223.020

88

Ra

Radium

226.025

92

U

Uranium

238.029

93

Np

Neptunium

237.048

94

Pu

Plutonium

244.064

95

Am

Americium

243.061

96

Cm

Curium

247.070

97

Bk

Berkelium

247.070

98

Cf

Californium

251.080

99

Es

Einsteinium

[254]

100

Fm

Fermium

257.095

101

Md

Mendelevium

258.1

102

No

Nobelium

259.101

103

Lr

Lawrencium

[262]

Periodic Table of the Elements

18

VIIA

8A

2

He

Helium

4.003

13

IIIA

3A

14

IVA

4A

15

VA

5A

16

VIA

6A

17

VIIA

7A

3

Li

Lithium

6.941

4

Be

Beryllium

9.012

11

Na

Sodium

22.990

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Manganese

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Zinc

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37

Rb

Rubidium

85.468

38

Sr

Strontium

87.62

43

Tc

Technetium

98.907

44

Ru

Ruthenium

101.07

45

Rh

Rhodium

102.906

46

Pd

Palladium

106.42

47

Ag

Silver

107.868

48

Cd

Cadmium

112.414

55

Cs

Cesium

132.905

56

Ba

Barium

137.328

61

Pm

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144.913

62

Sm

Samarium

150.36

63

Eu

Europium

151.964

64

Gd

Gadolinium

157.25

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Tb

Terbium

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Dy

Dysprosium

162.500

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Ho

Holmium

164.930

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Er

Erbium

167.259

69

Tm

Thulium

168.934

70

Yb

Ytterbium

173.055

71

Lu

Lutetium

174.967

21

Sc

Scandium

44.956

22

Ti

Titanium

47.867

23

V

Vanadium

50.942

24

Cr

Chromium

51.996

25

Mn

Manganese

54.938

26

Fe

Iron

55.845

27

Co

Cobalt

58.933

28

Ni

Nickel

58.693

29

Cu

Copper

63.546

30

Zn

Zinc

65.38

39

Y

Yttrium

88.906

40

Zr

Zirconium

91.224

41

Nb

Niobium

92.906

42

Mo

Molybdenum

95.95

43

Tc

Technetium

98.907

44

Ru

Ruthenium

101.07

45

Rh

Rhodium

102.906

46

Pd

Palladium

106.42

47

Ag

Silver

107.868

48

Cd

Cadmium

112.414

57-71

89

Ac

Actinium

227.028

90

Th

Thorium

232.038

91

Pa

Protactinium

231.036

92

U

Uranium

238.029

93

Np

Neptunium

237.048

94

Pu

Plutonium

244.064

95

Am

Americium

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Md

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102

No

Nobelium

259.101

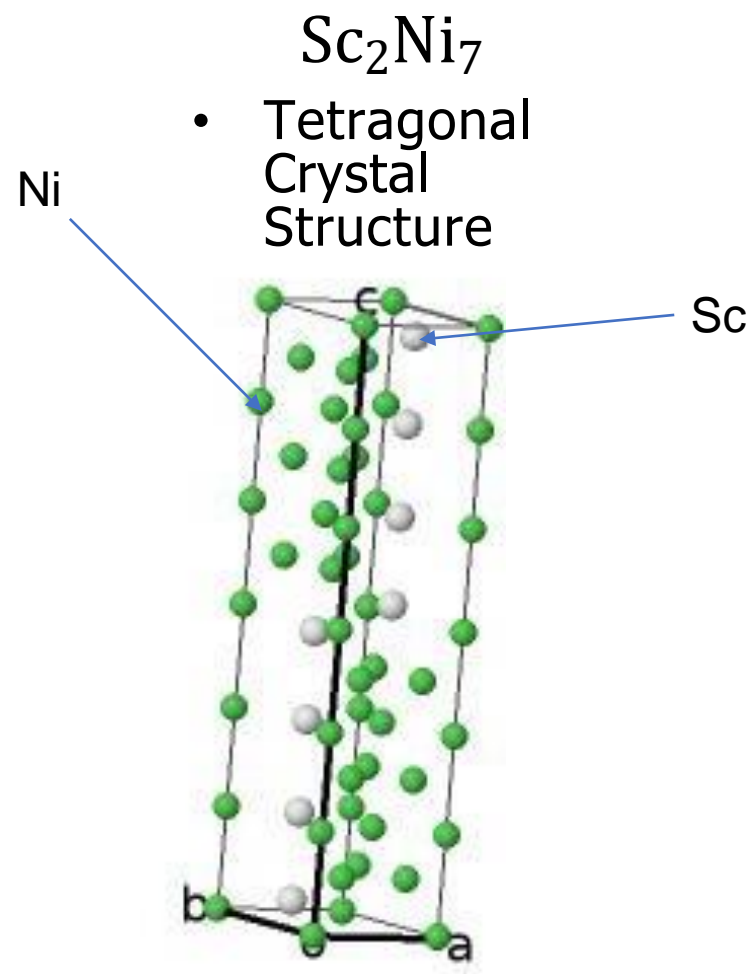
103

Lr

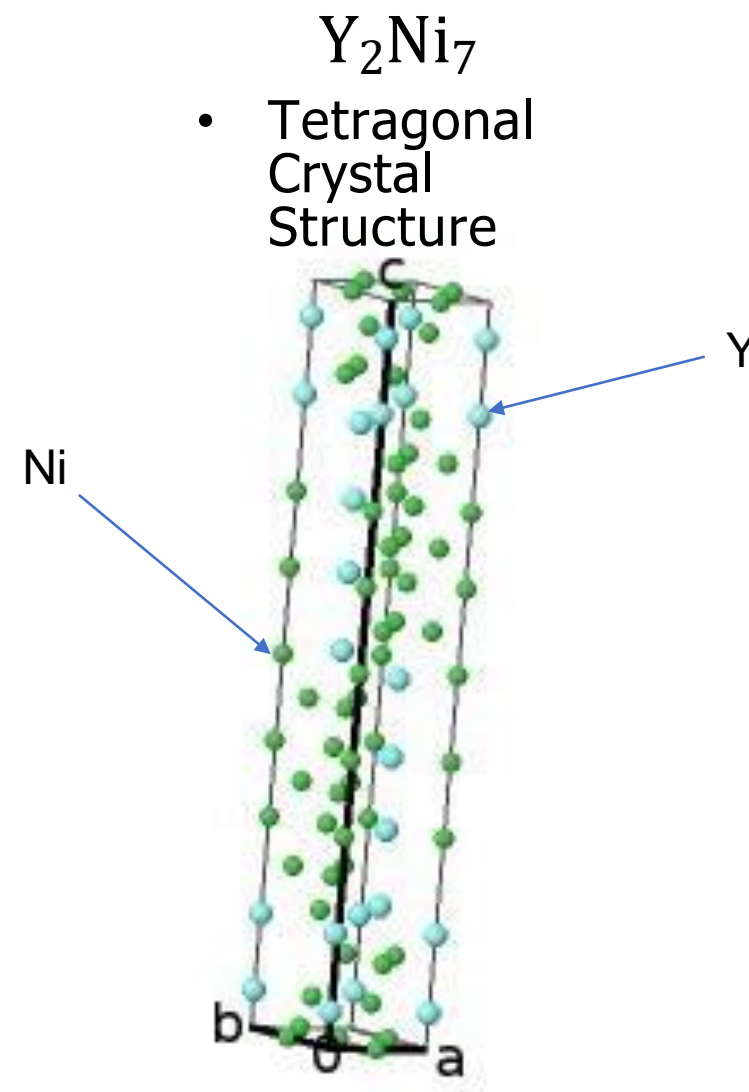
Lawrencium

[262]

# Sc<sub>2</sub>Ni<sub>7</sub> and Y<sub>2</sub>Ni<sub>7</sub>

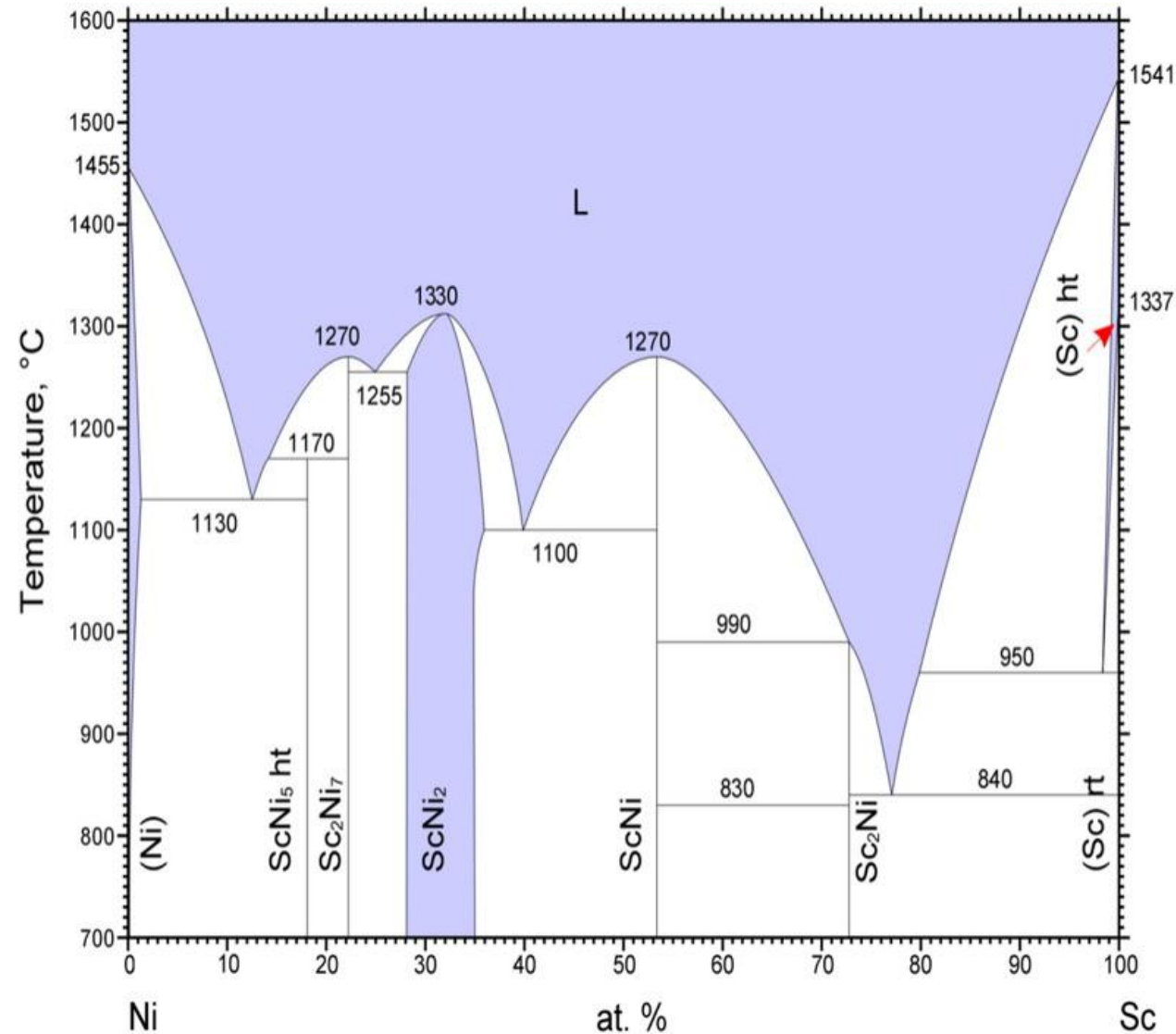


DOI: 10.1016/0022-5088(68)90142-2



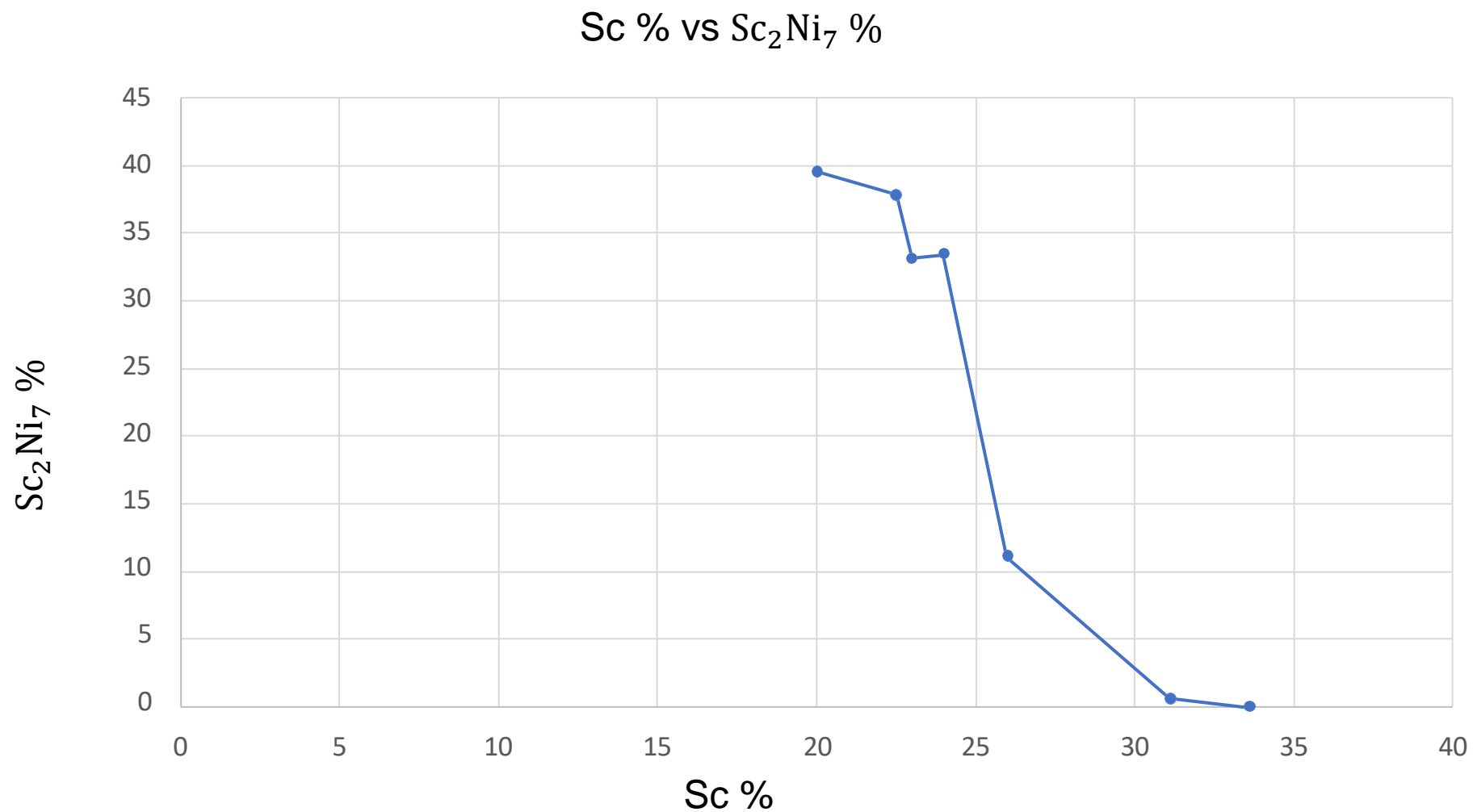
DOI: 10.30970/cma11.0375

# Binary Phase Diagrams





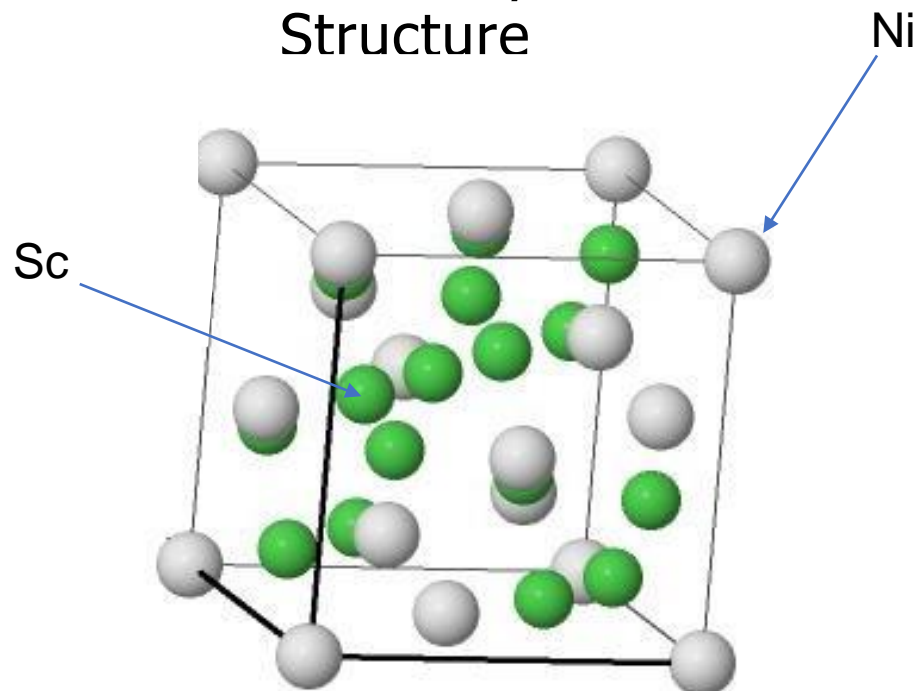
# Results for $\text{Sc}_2\text{Ni}_7$



# ScNi<sub>2</sub> and YNi<sub>2</sub>

## ScNi<sub>2</sub>

- Paramagnetic
- Cubic Crystal Structure

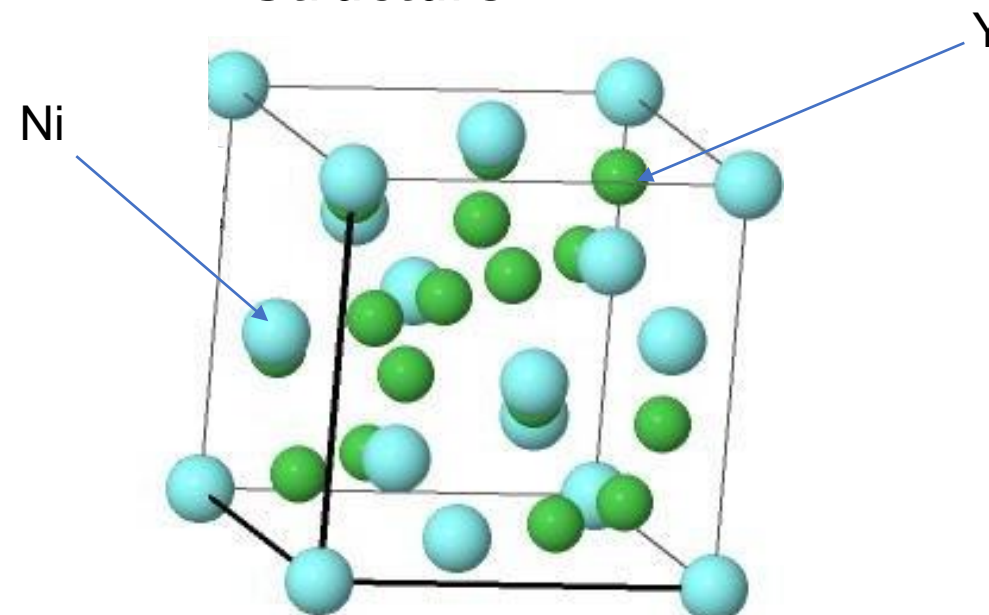


Goal: learn what Y-Sc substitution does to the paramagnetic state in ScNi<sub>2</sub>

Citation: S.B. Maslenkov, G.S. Braslavskaya, *Izvestiya Akademii Nauk SSSR, Metally*, 1984, 1984, 203

## YNi<sub>2</sub>

- Cubic Crystal Structure



DOI: 10.1016/0304-8853(85)90368-3

# Thanks

People from left to right:

- Gicela Saucedo
- Thomas Halloran
- Sylvia Lewin
- Nicholas Butch

