



# Controlled Expansion Alloys Electrical/Electronic Nickel

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**Nationwide Toll Free: 800.348.6268 • www.edfagan.com**

## ED FAGAN INC.

### ASTM F-15 ALLOY

**Description:** ASTM F-15 Alloy is a controlled expansion alloy consisting of 29% Nickel, 17% Cobalt, and balance Iron. It is produced to ensure good properties for machining and deep drawing as well as porosity free product. Its expansion characteristics match both borosilicate (Pyrex) glasses and alumina ceramics. It is one of the most popular of the controlled expansion alloys for hermetic sealing.

**Applications:** power tubes, microwave tubes, transistors, diodes, and hybrid packages.

**AKA:** Kovar<sup>1</sup>, Pernifer 2918<sup>2</sup>, Dilvar P1<sup>3</sup>, Rodar<sup>1</sup>, NILO K<sup>4</sup>

### Invar 36<sup>1</sup>

**Description:** A low expansion alloy, consisting of 36% Nickel, balance Iron. This alloy exhibits extremely low expansion around ambient temperatures and is often used where minimum expansion is required.

**Applications:** optoelectronics, optical and laser benches, electronics, and scientific instruments.

**AKA:** Invar<sup>3</sup>, Super Invar 32-5, Pernifer 36<sup>2</sup>, NILO 36<sup>4</sup>

### SUPER INVAR 32-5

**Description:** A low expansion alloy consisting of 32% Nickel, 5% Cobalt, balance Iron. This alloy exhibits minimum thermal expansion (one half of Invar 36) at room temperature.

**Applications:** In structural components, supports and substrates requiring precision measurements such as optical and laser systems, telescopes, laser bench tops, and ring laser gyroscopes.

### ALLOY 52

**Description:** A controlled expansion alloy, consisting of 51% Nickel, balance Iron; used in a wide variety of electronic applications, especially for glass seals.

**Application:** Glass to metal seals for electronic tubes, automotive and industrial lamps, and specialty hermetic devices.

**AKA:** Glass Seal 52\*, Pernifer 50<sup>2</sup>, NILO 50<sup>4</sup>

### ALLOY 48

**Description:** A controlled expansion alloy, consisting of 48% Nickel, balance Iron; used in a variety of electronic applications, especially for glass and ceramic seals.

**Application:** Glass to metal seals for variety of electronic tubes and hermetic devices.

**AKA:** Glass Seal 48\*, Pernifer 48<sup>2</sup>, NILO 48<sup>4</sup>

### ALLOY 42

**Description:** A controlled expansion alloy, consisting of 42% Nickel, balance Iron; used in a wide variety of electronic applications, lead frames, especially for glass and ceramic seals.

**Application:** Glass to metal seals for a wide variety of electronic tubes, hermetic packages, and automotive and industrial lamps.

**AKA:** Glass Seal 42\*, Pernifer 42<sup>2</sup>, NILO 42<sup>4</sup>

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**Though not a stock item. Ed Fagan Inc. can also supply Alloy 46.**

### ALLOY 46

**Description:** A controlled expansion alloy, consisting of 46% Nickel, balance Iron; used in a variety of electronic applications, especially for glass and ceramic seals.

**Application:** Glass to metal seals for electronic tubes and hermetic devices.

**AKA:** Glass Seal 46\*, Pernifer 46<sup>2</sup>, NILO 46<sup>4</sup>

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### Nickel 200/201/205/233

**Description:** Commercially pure, un-alloyed Nickel; used in electronics for packaging, leads, and lids.

**Applications:** Electronics industry, getter tabs, heating element sheathing, anodes, special purpose electron tubes, fuel cells, Ni-Cd batteries, transistor enclosures, spark gaps, terminals, anodes, cathode shields, semi-conductor supports, etc.

**AKA:** The Huntington Alloys

### Nickel 270

**Description:** Commercially pure, un-alloyed Nickel; used in electronics for packaging, leads, and lids.

**Applications:** Electronics industry, anode plates, hydrogen thyratron components, passive cathodes, cathode shanks, plater bars, and transistor enclosures.

### Footnotes

\* Glass Seal 42, 46, 48, and 52 manufactured by Carpenter Technology Corp., Reading PA

1. Trademark Carpenter Technology Corp., Reading PA

2. Trademark VDM Metals GmbH, Germany

3. Trademark Aperam Alloys, USA

4. Trademark Special Metals Corporation, USA

**THE MATERIALS YOU NEED, WHEN YOU NEED THEM**

# Controlled Expansion Alloys

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Physical Properties	Kovar	Alloy 52	Alloy 48	Alloy 46	Alloy 42	Invar 36	Super Invar 32-5
<b>DENSITY</b>							
<i>lb/cu in</i>	0.302	0.30	0.298	0.295	0.293	0.291	0.294
<b>SPECIFIC GRAVITY</b>	8.36	8.30	8.25	8.17	8.12	8.05	8.15
<b>CURIE TEMP</b>							
<i>°F</i>	815	986	880	860	716	535	470
<i>°C</i>	435	530	471	460	380	279	245
<b>MELTING POINT</b>							
<i>°F</i>	2640	2600	2600	2600	2600	2600	2600
<i>°C</i>	1449	1427	1427	1427	1427	1427	1427
<b>ELECTRICAL RESISTIVITY</b>							
<i>micro-ohm-cm</i>	49	44	49	47	68	84	82
<i>ohm-cir mil/ft</i>	294	258	290	277	400	495	481
<b>THERMAL CONDUCTIVITY</b>							
<i>W/cm °C</i>	0.17	0.14	0.13	0.11	0.11	0.10	0.10
<i>BTU-in/sq. ft-hr-°F</i>	120	97	90	79.2	74.5	72.6	72.6
<b>SPECIFIC HEAT</b>							
<i>Cal/g-°C</i>	0.11	0.12	0.12	0.12	0.12	0.123	0.12
<i>BTU/lbm-°F</i>	0.11	0.12	0.12	0.12	0.12	0.123	0.12
<b>Mechanical Properties</b>							
<b>TENSILE STRENGTH</b>							
<i>ksi</i>	75	80	79	80	82	75	70
<i>MPa</i>	518	552	545	552	566	518	483
<b>YIELD STRENGTH</b>							
<i>ksi</i>	40	40	36	35	34	40	40
<i>MPa</i>	276	276	248	242	235	276	276
<b>ELONGATION</b>							
<i>% in 2 in.</i>	30	35	30	30	30	34	40
<b>TYPICAL HARDNESS</b>							
<i>Rockwell (Annealed)</i>	Rb 80	Rb 80	Rb 80	Rb 80	Rb 80	Rb 80	Rb75
<b>MODULUS OF ELASTICITY</b>							
<i>Mpsi</i>	30	23	23	23	21.5	20.5	21.0
<i>kMPa</i>	207	159	159	159	148	141	145
<b>Chemistry</b>							
<i>maximum % unless noted</i>							
<b>Iron</b>	Bal	Bal	Bal	Bal	Bal	Bal	Bal
<b>Nominal Nickel</b>	29	50.5	48	46	41	36	32
<b>Nominal Cobalt</b>	17	-	-	-	-	0.5	5
<b>Carbon</b>	0.02	0.05	0.05	0.05	0.05	0.05	0.05
<b>Silicon</b>	0.20	0.30	0.30	0.30	0.30	0.40	0.25
<b>Sulfur</b>	-	0.025	0.025	0.025	0.025	0.015	0.015
<b>Chromium</b>	0.20	0.025	0.025	0.025	0.025	0.25	0.25
<b>Titanium</b>							
<b>Magnesium</b>							
<b>Specifications</b>							
<b>ASTM</b>	F-15	F-30	F-30	F-30	F-30	F-1684	F-1684
<b>MIL</b>	I-23011 CI 1	I-23011 CI 2	I-23011 CI 3	I-23011 CI 4	I-23011 CI 5	I-23011 CI 7	
<b>AMS</b>	I-23011 CI 1	I-23011 CI 2	I-23011 CI 3	I-23011 CI 4	I-23011 CI 5	I-23011 CI 7	

# Electrical/Electronic Nickel



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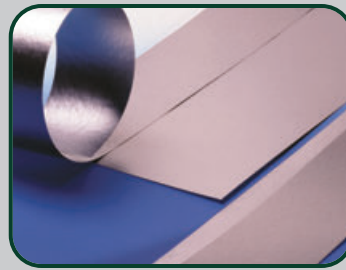
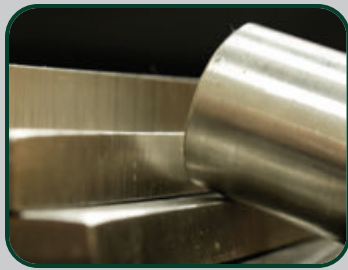
Nickel 200	Nickel 201	Nickel 205	Nickel 233	Nickel 270
0.321	0.321	0.321	0.321	0.321
8.89	8.89	8.89	8.89	8.89
680	680	680	680	680
360	360	360	360	360
2624	2624	2624	2624	2624
1440	1440	1440	1440	1440
8.5	8.5	9.5	7.7	7.5
51	51	57	46	45
0.79	0.79	0.75	0.81	0.86
550	550	520	565	600
0.108	0.108	0.108	0.108	0.108
0.108	0.108	0.108	0.108	0.108
65	65	65	65	65
449	449	449	449	449
20	20	20	20	20
138	138	138	138	138
40	40	40	40	40
30	30	30	30	30
207	207	207	207	207
0.25	0.25	0.2	0.2	0.005
99.5	99.5	99.5	99.5	99.97
-	-	-	-	0.001
0.07	0.02	0.07	0.1	0.02
0.25	0.25	0.15	0.1	0.001
0.01	0.01	0.008	0.008	0.001
-	-	-	-	-
	0.05	0.005		
	0.01- 0.10	0.01- 0.10		
B-160 / B-162	B-160 / B162	F-3 Gr 2	F-3 Gr 3	F-3 Gr 4
	5555			

If you need specialty metals or special purpose alloys for Aerospace/Aviation, Defense, Electronics, Ceramic, Heat Treating, Magnetic, Medical, Lighting, Optical, Telecommunications, or other high-technology, industrial applications, call Ed Fagan Inc.

EFI has supplied specialty metals, alloys, and hard-to-locate materials to these markets since 1965. We have a large, comprehensive inventory of Controlled Expansion Alloys, Electrical/Electronic Grade Nickel; as well as Soft Magnetic Alloys, and Refractory Metals and Alloys. We stock the highest quality materials available in forms such as: Bar, Rod, Sheet, Plate, Strip, Wire, and Foil... from the highest quality mills such as VDM Metals GmbH and Carpenter Technology. And, we stock these materials in many gauges, widths/lengths, and conditions for immediate delivery.

Our specialty is solving the inventory management problems of our customers. When you need a standard stock material quickly, we can have it shipped within 24 hours. And, all materials are certified with shipment. If your material requirement is too small to be of interest to the large producers, we'll use our buying power and expertise to source it for you. When you have a technical problem relating to an application using Controlled Expansion Alloys, Soft Magnetic Alloys, Refractory Metals and Alloys, or any other high-tech material, please call us; our in-house experts can help you solve your problems. If you have an unusual requirement, for instance an alloy, size or grade, our sales people are very knowledgeable and can assist you. If you have a special purpose material that you can't find, if we don't stock it, we'll use our Material-Locator service and try to find it for you.

We also offer Consignment Programs and Custom Stocking Programs to help you cut down your administrative burden, and streamline your manufacturing process. So call us now at 800-348-6268 to place an order or to speak with a materials expert. Or visit our website today, and use our "Request a Quote" link to find out how Ed Fagan Inc. can supply you with the materials you need, when you need them.



## FORMS AVAILABLE

	Kovar	Alloy 52	Alloy 48	Alloy 42	Invar 36	Super Invar 32-5	Nickel 200/201	Nickel 205/233	Nickel 270
<b>Rod</b>	0.050" - 6.0"	0.040" - 0.312"	0.140" - 4.0"	0.500" - 2.0"	0.050" - 6.0"	0.8125" - 3.543"	0.125" - 3.0"	*	0.125" - 3.5"
<b>Sheet</b>	0.005" - 0.125" *	*	*	0.020" - 0.125"	0.030" - 0.125"	0.0394" - 0.1181"	0.030" - 0.125"	*	
<b>Plate</b>	0.187" - 1.0"	*	*	*	0.150" - 3.0"	0.500" - 2.0"	*	*	*
<b>Strip/Coil</b>	0.005" - 0.143"	0.010" - 0.050"	*	0.005" - 0.062"	*	*	0.010" - 0.062"	0.010" - 0.062"	*
<b>Photo-Etch</b>	0.005" - 0.020" *	*	*	*	*	*	*	*	*

If you do not see the size or form you require listed above, please call us. We add new stock material frequently, and may have the size and form you need.  
 \*Though not a standard stock item, we may be able to supply you with the exact size, shape & quantities you require. Alloy 46 not a standard stock item.

## LINEAR COEFFICIENT OF THERMAL EXPANSION (cm/cm per °C x 10<sup>-6</sup>)

Deg. °C	Class 1	Class 2	Class 3	Class 4	Class 5	Class 7	
	Kovar	Alloy 52	Alloy 48	Alloy 46	Alloy 42	Invar 36	Super Invar 32-5
30-100	—	10.5	9.4	8.2	4.8	0.8-1.6	0.84
30-150	—	10.5	9.4	8.1	4.6	—	1.17
30-200	5.5	10.4	9.4	7.9	4.5	1.3-2.1	1.72
30-250	—	10.4	9.3	7.8	4.5	—	2.53
30-300	5.1	10.2	8.8	7.5	4.0-4.7	4.92	4.16
30-325	—	—	—	—	4.7	—	—
30-350	—	10.2	9.0	7.1-7.8	5.0	6.2-7.0	5.74
30-375	—	—	—	7.5	5.5	—	—
30-400	4.6-5.2	10.1	8.2-9.2	7.5	6.0	7.8	7.03
30-425	—	—	8.9	7.6	—	—	—
30-450	5.1-5.5	9.6-10.1	9.0	7.9	6.7-7.4	8.5-9.2	—
30-475	—	10.1	9.3	—	—	—	—
30-500	6.2	10.0	9.4	8.2-8.9	8.0	9.7	8.99
30-525	—	10.4	—	—	—	—	—
30-550	—	10.2-10.7	9.6-10.3	9.3	8.8	—	10.56
30-600	7.9	10.8	10.4	9.8	9.5	11.4	—
30-700	9.3	11.7	11.3	10.7	10.5	12.7	—
30-800	10.4	12.5	12.1	11.6	11.4	13.5	—
30-900	11.5	13.3	13.0	12.5	12.3	13.9	—
30-1000	—	14.2	13.9	13.4	13.2	—	—

Hyphenated values above are the expected values as per MIL/AMS I 23011.

EFI also has a large inventory of Special Purpose Materials, Metals and Alloys for Refractory, Soft Magnetic and other Applications.



6/2020

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