



ED FAGAN INC.

Controlled Expansion Alloys Electrical/Electronic Nickel

ED FAGAN EUROPE LTD.

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Alloy ASTM F-15

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: Kovar¹, Pernifer 2918², Dilvar P1³, Rodar¹, NILO K⁴

Invar 36¹

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 36¹, Pernifer 36², NILO 36⁴, Invar³

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: Pernifer 50², NILO 50, Glass Seal 52¹

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: Pernifer 48², NILO 48, Glass Seal 48¹

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: Pernifer 46², NILO 46, Glass Seal 46¹

Alloy 42

Description: A controlled expansion alloy, consisting of 42% Nickel, balance Iron; used in a wide variety of electronic application, 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: Pernifer 42², NILO 42⁴, Glass Seal 42¹

Alloy 42-6

Description: A controlled expansion alloy, consisting of 42% Nickel, 6% Chromium, balance Iron; used in a wide variety of electronic applications, especially for glass seals

Application: Glass to metal seals for a variety of electronic tubes and CRT tubes.

AKA: Glass Seal 42-6¹

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 thyatron components, passive cathodes, cathode shanks, plater bars, and transistor enclosures.

Footnotes

1. Trademark Carpenter Technology Corp., Reading PA
2. Trademark ThyssenKrupp-VDM, Germany
3. Trademark Imphy Alloys, France
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	Alloy 42-6	Invar 36
DENSITY							
<i>lb/cu in</i>	0.302	0.3	0.298	0.295	0.293	0.293	0.291
SPECIFIC GRAVITY	8.36	8.3	8.25	8.17	8.12	8.12	8.05
CURIE TEMP							
<i>°F</i>	815	986	880	860	716	560	535
<i>°C</i>	435	530	471	460	380	293	279
MELTING POINT							
<i>°F</i>	2640	2600	2600	2600	2600	2600	2600
<i>°C</i>	1449	1427	1427	1427	1427	1427	1427
ELECTRICAL RESISTIVITY							
<i>micro-ohm-cm</i>	49	44	49	47	68	97	84
<i>ohm-cir mil/ft</i>	294	258	290	277	400	570	495
THERMAL CONDUCTIVITY							
<i>W/cm °C</i>	0.17	0.14	0.13	0.11	0.11	0.13	0.10
<i>BTU-in/sq. ft-hr-°F</i>	120	97	90	79.2	74.5	87	72.6
SPECIFIC HEAT							
<i>Cal/g-°C</i>	0.11	0.12	0.12	0.12	0.12	0.12	0.123
<i>BTU/lbm-°F</i>	0.11	0.12	0.12	0.12	0.12	0.12	0.123
THERMAL EXPANSION							
<i>ppm/°F (75°F to 842°F)</i>	2.9	5.5	5.0	4.4	3.9	5.9	4.9
<i>ppm/°C (25°C to 450°C)</i>	5.3	9.9	9.0	7.9	7.0	10.6	8.9
Mechanical Properties							
TENSILE STRENGTH							
<i>ksi</i>	75	80	79	80	82	80	75
<i>MPa</i>	518	552	545	552	566	552	518
YIELD STRENGTH							
<i>ksi</i>	40	40	36	35	34	40	40
<i>MPa</i>	276	276	248	242	235	276	276
ELONGATION							
<i>% in 2 in.</i>	30	35	30	30	30	30	34
TYPICAL HARDNESS Ann.							
<i>Rockwell</i>	HRB 80	HRB 80	HRB 80	HRB 80	HRB 80	HRB 80	HRB 80
MODULUS OF ELASTICITY							
<i>Mpsi</i>	30	23	23	23	21.5	23	20.5
<i>kMPa</i>	207	159	159	159	148	159	141
Chemistry							
<i>maximum % unless noted</i>							
Iron	Bal	Bal	Bal	Bal	Bal	Bal	Bal
Nominal Nickel	29	50.5	48	46	41	42	36
Nominal Cobalt	17	-	-	-	-	-	0.5
Carbon	0.02	0.05	0.05	0.05	0.05	0.07	0.05
Silicon	0.20	0.30	0.30	0.30	0.30	-	0.40
Sulfur	-	0.025	0.025	0.025	0.025	0.025	0.015
Chromium	0.20	0.025	0.025	0.025	0.025	5.6 nom.	0.25
Titanium							
Magnesium							
Specifications							
ASTM	F-15 / F-1466	F-30	F-30	F-30	F-30	F-31	F-1684
MIL	I-23011 CI 1	I-23011 CI 2	I-23011 CI 3	I-23011 CI 4	I-23011 CI 5	I-23011 CI 6	I-23011 CI 7
AMS	I-23011 CI 1	I-23011 CI 2	I-23011 CI 3	I-23011 CI 4	I-23011 CI 5	I-23011 CI 6	I-23011 CI 7

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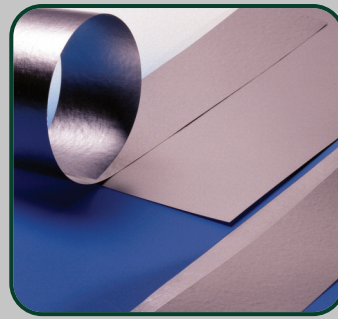
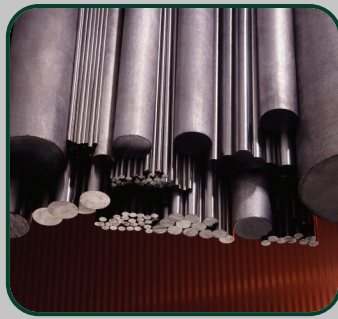
Nickel 200	Nickel 201	Nickel 205	Nickel 233	Nickel 270
0.321	0.321	0.321	0.321	0.321
8.89	8.89	8.89	8.89	8.89
680	680	680	680	680
360	360	360	360	360
2624	2624	2624	2624	2624
1440	1440	1440	1440	1440
8.5	8.5	9.5	7.7	7.5
51	51	57	46	45
0.79	0.79	0.75	0.81	0.86
550	550	520	565	600
0.108	0.108	0.108	0.108	0.108
0.108	0.108	0.108	0.108	0.108
7.2 (212°F)	7.2 (212°F)	7.2 (212°F)	7.2 (212°F)	7.2 (212°F)
13 (100°C)	13 (100°C)	13 (100°C)	13 (100°C)	13 (100°C)
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

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

Ed Fagan Europe Ltd. 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 ThyssenKrupp VDM, Carpenter Technology and Plansee. 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 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.

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FORMS AVAILABLE

	Kovar	Alloy 52	Alloy 48	Alloy 46	Alloy 42	Invar 36	Nickel 200/201	Nickel 205/233	Nickel 270
Rod	1.27 - 152.4 mm	0.254 - 3.175 mm	1.574 - 28.575 mm	*	*	3.175 - 152.4 mm	6.35 - 50.8 mm	*	3.175 - 88.9 mm
Sheet	0.254- 3.175 mm	*	*	*	0.508- 2.54 A	0.762 - 3.175 mm	0.762 - 3.175 mm	*	
Plate	4.165 - 25.4 mm	*	*	*	6.858 mm A	3.81 - 101.6 mm	*	*	*
Strip/Coil	0.127 - 1.524 mm A.	0.254 - 0.381 mm A	0.025 - 2.032 A	*	0.254 - 1.016 mm A	*	0.101 - 1.27 mm	*	*
	0.254 - 0.381 mm T	*	*	*	*	*	*	*	*
Photo-Etch	*	*	*	*	*	*	*	*	*

**Though not a standard stock item, we may be able to supply you with the exact size, shape & quantities you require. Please call.*

LINEAR COEFFICIENT OF THERMAL EXPANSION (ppm per °C)

Deg. °C	Class 1 Kovar	Class 2 Alloy 52	Class 3 Alloy 48	Class 4 Alloy 46	Class 5 Alloy 42	Class 6 Alloy 42-6	Class 7 Invar 36
30-100	—	10.5	9.4	8.2	4.8	—	0.8-1.6
30-150	—	10.5	9.4	8.1	4.6	—	—
30-200	5.5	10.4	9.4	7.9	4.5	—	1.3-2.1
30-250	—	10.4	9.3	7.8	4.5	—	—
30-300	5.1	10.2	8.8	7.5	4.0-4.7	8.2	4.92
30-325	—	—	—	—	4.7	—	—
30-350	—	10.2	9.0	7.1-7.8	5.0	8.5-9.2	6.2-7.0
30-375	—	—	—	7.5	5.5	—	—
30-400	4.6-5.2	10.1	8.2-9.2	7.5	6.0	10.0	7.8
30-425	—	—	8.9	7.6	—	9.7-10.4	—
30-450	5.1-5.5	9.6-10.1	9.0	7.9	6.7-7.4	10.6	8.5-9.2
30-475	—	10.1	9.3	—	—	—	—
30-500	6.2	10.0	9.4	8.2-8.9	8.0	11.2	9.7
30-525	—	10.4	—	—	—	—	—
30-550	—	10.2-10.7	9.6-10.3	9.3	8.8	11.7	—
30-600	7.9	10.8	10.4	9.8	9.5	12.2	11.4
30-700	9.3	11.7	11.3	10.7	10.5	13.0	12.7
30-800	10.4	12.5	12.1	11.6	11.4	13.7	13.5
30-900	11.5	13.3	13.0	12.5	12.3	14.6	13.9
30-1000	—	14.2	13.9	13.4	13.2	15.4	—

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

For customers in North America, contact 800.348.6268
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