

High Purity Nickel Strip



Advantages

AMETEK High Purity Nickel offers advantages to the rechargeable battery industry. Typical applications for rechargeable batteries include computers, cellular phones, power tools, electric vehicles, and camcorders. Other advantages offer:

- Lowest electrical resistivity available in pure nickel strip.
- Homogeneity, microcleanliness, and close composition control enhances weldability.
- Significantly low levels of surface oxides reduce die wear and provide excellent solderability.
- Excellent formability.

CHEMICAL COMPOSITION IN PERCENT *(Maximum values except where noted otherwise)*

	899A	899L	899M	899D	899E	899G	ASTM B-162; UNS	
	HIGH PURITY			DISPERSED PHASE			N02200	N02233
Nickel-Nominal	99.97 ^(a)	99.8	99.6	99.6	99.5	99.6	-	-
C-Nominal	0.005	0.005	0.005	0.01	0.01	0.01	-	-
C	0.02	0.02	0.02	0.02	0.02	0.02	0.15	0.15
Si	0.001	0.001	0.001	0.002	0.002	0.002	0.35	0.10
Mn	0.001	0.07	0.25	0.25	0.25	0.022-0.042	0.35	0.30
S	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.008
Cu	0.001	0.005	0.005	0.005	0.005	0.01	0.25	0.10
Fe	0.005	0.05	0.05	0.05	0.05	0.05	0.40	0.10
Sn	-	-	-	-	0.07	-	-	-
Mg	-	-	-	0.035	0.0035	0.006-0.014	-	0.10
Equivalent	N02270	N02200 N02201	N02200 N02201	N02233	N02201	N02205	-	-

(a) This is a minimum, not nominal value.

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ELECTRICAL RESISTIVITY AT 70°F FOR 899 NICKEL (OHM/CMF)

NICKEL GRADE	ANNEALED	50% COLD WORK
899A	44.5	45.0
899L	45.1 ^(a)	45.6
899M	46.7	47.2
899D	47.3	47.8
899E	48.1	48.6
899G	45.0	45.5
COMPARATIVE DATA FOR WROUGHT AND CAST NICKEL		
UNS N02270	45.0 ^(b)	-
UNS N02201	59.6	62.2
UNS N02201	52.0 ^(b)	-
UNS N02200	57.0	59.2

(a) Wrought Powder Metallurgy (b) Handbook Value

SOFTENING TEMPERATURE FOR 899 NICKEL

TYPE	GRADE	SOFTENING POINT FOR 50% COLD ROLLED TEMPER	
		SOFTENING CURVE ¹ KNEE, TEMPERATURE °F	HALF HARD SOFTENING ² TEMPERATURE °F
H.P.	A	640	680
H.P.	L	750	800
H.P.	M	870	910
D.P.	D	910	970
D.P.	E	960	1010
D.P.	G	710	750

¹ Approximate temperature at which rapid softening occurs. Refer to included softening curves.

² Defined as that temperature at which one half of the hardness imparted by cold rolling is lost during 30 minutes time at temperature softening test.

MECHANICAL PROPERTY COMPARISONS (899 Nickels in the 50% Cold Rolled and Annealed (30 min. at 1450°F) Condition)

ANNEALED PROPERTIES					50% COLD ROLLED PROPERTIES				
TYPE	GRADE	TENSILE STRENGTH ksi	YIELD STRENGTH ksi	ELONGATION % IN 2 INCHES	VICKER HARDNESS	TENSILE STRENGTH ksi	YIELD STRENGTH ksi	ELONGATION % IN 2 INCHES	VICKER HARDNESS
H.P.	A	53.0	15.0	44	70	93.5	90.5	2-10	203
H.P.	L	53.5	15.5	44	73	97.0	94.0	2-8	208
H.P.	M	57.5	16.5	43	78	98.5	95.5	2-5	210
D.P.	D	59.2	18.5	42	85	101.0	99.0	2-5	220
D.P.	E	61.0	20.0	42	86	102.0	100.0	2-5	224
COMPARATIVE DATA FOR WROUGHT AND CAST ALLOYS									
UNS N02201		57.7	17.3	42	95	98.5	96.5	1-4	209

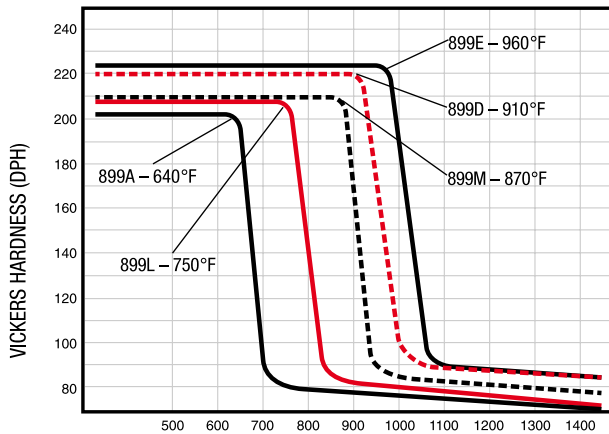
RANGE OF TYPICAL MECHANICAL PROPERTIES FOR 899 A-L-M NICKELS

TEMPER	UTS	0.2% YS	ELONGATION	ROCKWELL B	VICKERS HARDNESS
Annealed	50-58	15-20	40-45	46 max.	64-90
Skin Hard	52-65	20-45	30-40	64-70	110-126
1/4 Hard	55-70	25-55	20-35	70-80	120-151
1/2 Hard	60-80	50-75	15-25	79-86	148-171
3/4 Hard	70-90	65-85	5-10	85-91	168-193
Hard	85-100	80-95	3-6	91 min.	193-203
Full Hard	94-103	90-100	12	93 min.	>203

899 Nickel Strip meets ASTM B-162, ASTM F-3, ASTM F-239, MIL-N-19153 and MIL-N-46025

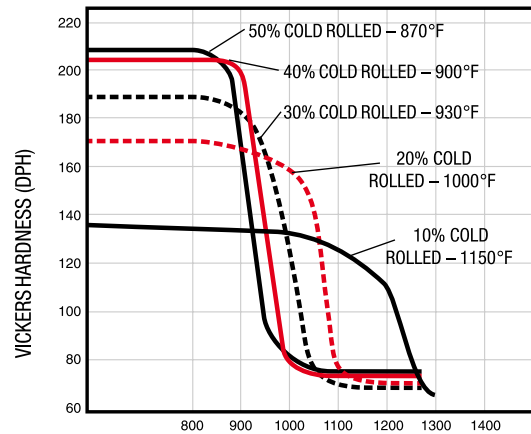
TYPICAL SOFTENING CURVES

SELECTED 50% COLD ROLLED 899 NICKEL GRADES



TEMPERATURE °F (30 minutes at temperature tests)

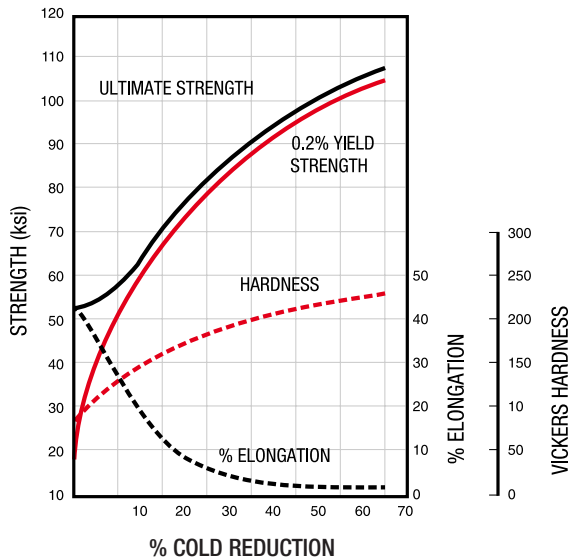
899M NICKEL (0.2% Mn)



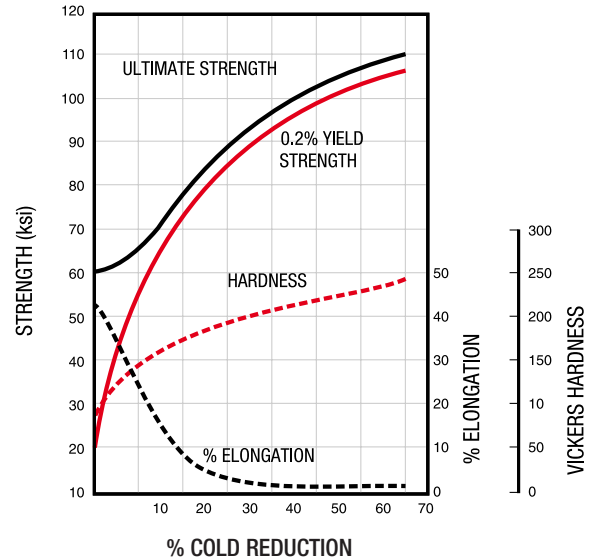
TEMPERATURE °F (30 minutes at temperature tests)

TYPICAL COLD ROLLED CURVES

899L



899E



RECRYSTALLIZATION GRAIN GROWTH COMPARISON (AMETEK Wrought Powder Metallurgy Nickel and Wrought Cast Nickel)

NI GRADE	ASTM GRAIN SIZE BEFORE 50% COLD ROLLED	ASTM GRAIN SIZE AFTER INDICATED HEAT TREATMENT, °F				
		30 MIN./ 1200°F	30 MIN./ 1450°F	1 HR./ 1800°F	1 HR./ 2000°F	1 HR./ 2200°F
899A	7.5	7.0	7.0	7.0	2.0	2.0
899L	8.5	8.5	8.0	7.5	7.0	5.0
899M	8.0	8.0	7.5	7.5	7.0	5.5
899D	10.0	10.0	9.0	9.0	9.0	8.5
899E	10.0	10.0	9.0	9.0	9.0	8.5
899G	9.0	9.0	8.5	8.0	7.5	7.0
N02233	8.0	8.0	6.5	4.5	3.5	2.5
N02201	8.0	8.0	7.5	3.0	2.0	2.0

Specifications Subject to Change Without Notice.

SPECIFICATIONS

PHYSICAL PROPERTIES

(Typical Handbook Values for Pure Nickel)

DENSITY AT 70°F

8.90 g/cc; 0.322 lb./cu.in.

COEFFICIENT OF LINEAR EXPANSION (IN./IN.-°C)

20-100°C 0.000014
20-200°C 0.000014
20-500°C 0.000015
20-700°C 0.000016

YOUNG'S MODULUS, E, PSI X 10⁻⁶

30.1

ELECTRICAL CONDUCTIVITY

22.6% IACS

ELECTRICAL RESISTIVITY AT 20°C

microhm-cm: 7.63
ohms/cir. mil./ft.: 45.9

THERMAL CONDUCTIVITY

70 W/m-K
487 BTU-in/hr-ft² °F

TEMPERATURE COEFFICIENT OF ELECTRICAL RESISTIVITY

20-100°C 0.0058
20-500°C 0.0074
20-800°C 0.0060

ATOMIC NUMBER

28

ATOMIC WEIGHT

58.1

ATOMIC RADIUS (A)

1.25

CRYSTAL STRUCTURE

f.c.c.

LATTICE CONSTANT "a" (A)

3.52

MELTING POINT

1,453°C; 2,647°F

LATENT HEAT OF FUSION

73.8 cal./g.

SPECIFIC HEAT AT 20°C-BTU/lb./°F

0.105

ELECTRODE POTENTIAL

0.25 volts

VELOCITY OF SOUND

16,300 ft./sec.; 4,973 m/sec.

POISSON'S RATIO

0.31

THERMAL NEUTRON CROSS SECTION (BARNS)

Absorption: 4.6
Scattering: 17.5

CURIE TEMPERATURE

353°C; 665°F

MAGNETIC PROPERTIES

(Typical Handbook Values for Pure Nickel)

CURIE TEMPERATURE

353°C; 665°F

INITIAL PERMEABILITY

130

MAXIMUM PERMEABILITY

124

SATURATION INDUCTION, GAUSS (B)

6050

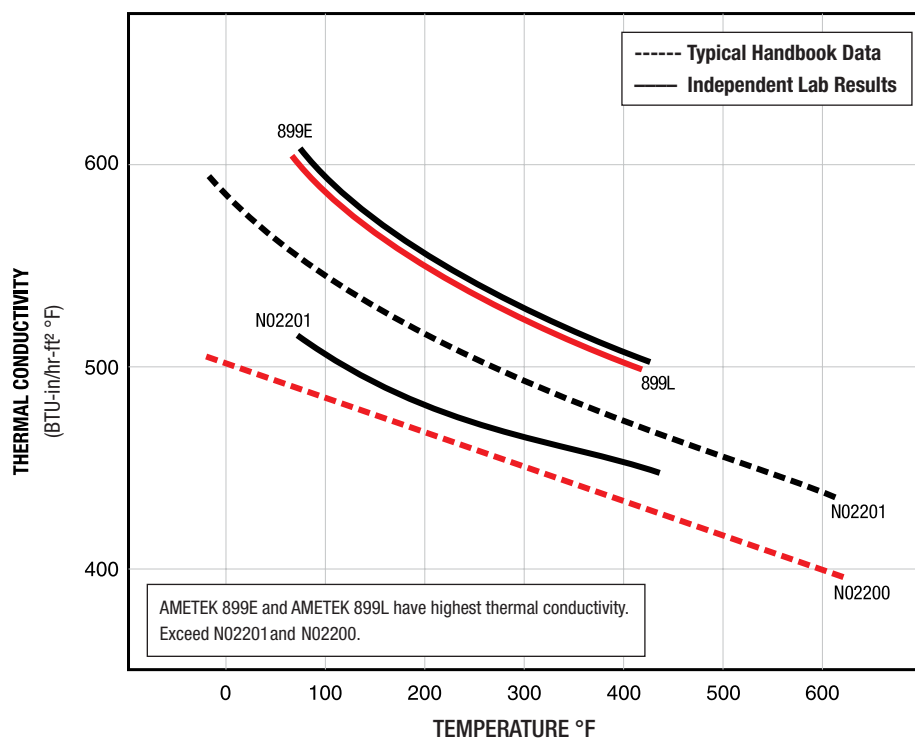
REMANENCE, GAUSS (B)

3250

COERCIVITY, OERSTEDS (H)

3.0

THERMAL CONDUCTIVITY



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