ARGONNE
NATIONAL
LABORATORY

INTRA-LABORATORY MEMO

Jan. 4, 1991

To: Tuncer M. Kuzay

From: Zhibi Wang ZW

Subject: Thermophysical and Mechanical Properties for Glid-Cop

After several days compilation, a preliminary version of Glidcop data is ready, in which I have tried to put in all the data that are available to me at this moment. The effort is still going on to incorporate more data. Please make comments and suggestions, and correct possible erratum.

cc: Jeff Collins
Ali Khounsary
Tom Nian
Deming Shu

Glid-COP Properties

Room Temperature Properties of Glidcop and OF Copper

Property		Grade AL-15	Grade AL-25	Grade AL-60	Grade OFCu
Aluminum Oxide	Weight %	0.28	0.46	1.12	'
Melting Point	deg C	1083	1083	1083	1083
	deg F	1981	1981	1981	1981
Density	(Mg./cub. m)	8.90	8.86	8.81	8.94
	(lb./cub. in)	0.321	0.320	0.318	0.323
Electrical Conductivity	at 20 deg C (Meg S/m.)	54	50	45	58
	at 68 deg F (% IACS)	92	87	78	101
Thermal Conductivity	at 20 deg C (W/(m.K.))	365	344	322	391
	at 68 deg F (BTU/ft.hr.F)	211	199	186	226
Coeff. Thermal Expan.	20-1000 deg C micrometer/m. C	16.6	16.6	16.6	17.7
	68-1832 deg F Microinch/inch. F	9.2	9.2	9.2	9.8
Modulus of Elasticity	(Gpa)	130	130	130	115
	(Mpsi)	19	19	19	17
Poisson's Ratio	at 50 deg C	0.326			0.343
Specific Heat	at 20 deg C (J/kg K)	391			385
Yield Strength (MPa)	As Consolidated	331	345	413	6 ksi (1300F anneal) *
(2% offset)	75% Cold Worked	455	467	572	47-54 ksi (0.040-0.015mm grain size) *
Tensile Strength (MPa)	As Consolidated	413	434	517	32 ksi (1300F anneal) *
	75% Cold Worked	483	524	627	50-56 ksi *
Elongation Percent	As Consolidated	24	21	13	43 *
	75% Cold Worked	10	9	9	3 *

* Handbook of Engineereing Materials, Ed Douglas F. Miner and John B. Seastone, 1st ed. John Wiley & Sons, Inc.

4.408 X 10^7 psi

MPT

Material	Density rho g/mm^3	Elastic Modulus Pascal	Poisson's ratio	Coeff. of Thermal Expansion °K^-1	Thermal Conductivity W/mm-°K	Specific Heat J/g-°K	K/alpha	0.20% Yield Strength Annealed
Air, 26 Deg C	1.18E-06				2.61E-05	1.00E+00		
Aluminum, Pure		4.90E+08	0.334		2.37E-01	0.00E+00		
Aluminum, 6061-T6	2.71E-03	4.90E+08	0.334	2.25E-05	1.71E-01	9.60E-01	7.60E+03	
Alum-Carbide SXA 24-16	2.91E-03	8.07E+08		1.30E-05	1.25E-01	7.95E-01	9.62E+03	
Beryllium I-70	1.85E-03	3.04E+11	0.03	1.12E-05	2.20E-01	1.82E+00	1.96E+04	
Cement mortar	1.90E-03				7.20E-04			
Concrete - lightweight	1.40E-03				8.65E-04	9.62E-01		
Ductile Cast Iron	7.20E-03	1.72E+11	0.25	1.35E-05	3.29E-02		2.43E+03	
Diamond, Type IIa (150°C)		1.03E+12	0.2	1.50E-06	1.50E+00		1.00E+06	
Douglas Fir		1.10E+10						
Fused Silica	2.20E-03	7.32E+10		5.60E-07	1.37E-03	7.41E-01	2.45E+03	
Germanium	5.33E-03	8.30E+10		6.00E-06	5.90E-03	3.10E-01	9.83E+02	
Glass BK-7	2.53E-03	8.07E+10		7.10E-06	1.12E-03	8.79E-01	1.58E+02	
GlidCop AL-15 50°C	8.84E-03	1.07E+11	0.326	1.66E-05	3.40E-01		2.05E+04	
Granite	2.50E-03				2.60E-03			
Graphite-Epoxy low CTE G70	1.80E-03	9.30E+10		5.00E-08	3.50E-02	9.21E-01	7.00E+05	
Invar 36	8.03E-03	1.45E+11	0.259	5.40E-07	1.38E-02	5.02E-01	2.56E+04	
Lead	1.10E-02	3.65E+10	0.44	2.91E-05	3.48E-02	1.30E-01	1.20E+03	
Molybdenum	1.00E-02	3.10E+11	0.293	6.70E-06	1.30E-01	2.47E-01	1.94E+04	
Monel 400	8.83E-03	1.79E+11	0.32	1.39E-05	2.18E-02	4.19E-01	1.57E+03	25-50
Nickel 200	8.89E-03	2.04E+11	0.264	1.33E-05	6.71E-02	4.56E-01	5.05E+03	22.3
Nickel 201	8.89E-03	2.04E+11	0.264	1.33E-05	7.38E-02	4.56E-01	5.55E+03	15.4
Nickel 270	8.89E-03	2.04E+11	0.264	1.33E-05	7.90E-02	4.56E-01	5.94E+03	16
OFHC Copper	8.92E-03	1.19E+11	0.343	1.77E-05	3.99E-01	3.85E-01	2.25E+04	
Pyrex	2.23E-03	6.55E+10		3.30E-06	1.13E-03	8.38E-01	3.42E+02	
Sapphire	3.98E-03	3.45E+11		8.40E-06	2.72E-02	4.19E-01	3.24E+03	
Silicon	2.31E-03	1.23E+11		2.50E-06	1.50E-01	5.44E-01	6.00E+04	
Silicon Carbide (CVD)	3.14E-03	4.48E+11	0.142	2.90E-06	2.00E-01		6.90E+04	
Silicon Carbide (sintered)	3.14E-03	4.07E+11	0.142	4.02E-06	1.26E-01		3.13E+04	
Steel - 304 S.S.	8.03E-03	1.93E+11	0.305	1.73E-05	1.62E-02	5.00E-01	9.38E+02	
Steel - low carbon	7.86E-03	2.07E+11	0.291	1.21E-05	5.19E-02		4.30E+03	
Titanium		1.20E+11	0.361	8.80E-06	1.60E-02	5.19E-01	1.82E+03	
Tungsten		4.11E+11	0.28	4.50E-06	1.67E-01	1.34E-01	3.71E+04	
Tungsten Carbide	1.52E-02	6.47E+11	0.22	4.54E-06	1.21E-01		2.67E+04	
ULE Fused Silica	2.20E-03	6.77E+10		1.00E-07	1.31E-03	7.66E-01	1.31E+04	
Water	1.00E-03				6.06E-04	4.18E+00		
Zerodur	2.53E-03	9.10E+10		1.00E-07	1.64E-03	8.21E-01	1.64E+04	
Blue denotes recent changes								
[W/m K] =1.73 x [Btu/hr ft °F]								
[psi] = 1/6894 x [Pa]								

1.5515 X 10^7 psi

Glid-cop Properties

SCM MTL UT, J. D. Troxell

Mechanical Properties of Glidcop AL15 LOX with Different Plates Thickness

Thickness (mm)	Cold Reduction (%)	UTS (MPa)	0.2% YS (MPa)	Elogation (% in 25mm)	Hardness (HRB)
28.0	58	475	427	10	74
12.5	75	482	455	10	78
3.0	93	552	524	7	79

Mechanical Properties of Glidcop AL15 LOX with Different Plates Thickness (after stress relief heat treatment)

Thickness (mm)	Cold Reduction (%)	UTS (MPa)	0.2% YS (MPa)	Elogation (% in 25mm)	Hardness (HRB)
12.5	75	469	441	11	77
3.0	93	530	500	10	78

Swelling in Neutron Irradiated Glidcop DSC and Copper Alloys

Material	Vol % Increase after Irradiation	
	3dpa	15dpa
C15720	0.8	0.9
C15760	1.1	0.6
OF Copper (99.95%)	1.8	6.8
Marz Copper (99.999%)	2.1	6.6
Copper-Zirconium	nil	3.6

Mechanical Properties of Irradiated Glidcop DSC and Copper Alloys

Material	Condition	UTS (MPa)	0.2% YS (MPa)	Elongation (%)
C15720	Control	395	337	14
	15 dpa	395	343	20
C15760	Control	466	397	12
	15 dpa	449	379	11
OF Cu	Control	196	26	27
	15 dpa	185	49	24
Marz Cu	Control	152	31	24
	15 dpa	149	41	17
CU-Zr	Control	334	271	9
	15 dpa	226	71	34

Glid-cop AL15 and A SCM MTL UT

Cryogenic Temperature Tensile Properties (AL-15 12.5mm Thick Plate)*

Temperature (K)	UTS (MPa)	0.2% YS (MPa)	Elongation (%)
293	482	455	10
77	655	550	21

* By University of Texas

Room Temperature Properties AL-15, AL25

Grade	UTS(MPa)	0.2% YS (MPa)	Elongation (%)	Hardness(RB)
AL-15	358	241	24	60
AL-25	413	297	16	65

Room Temperature Tensile Properties As Drawn vs After Braze Cycle
(AL-15 9.5 mm OD, .76 mm Wall) (by Sandia)

Condition	UTS (MPa)	0.2% YS (MPa)	Elongation (%)	Reduction in Area (%)
As Drawn	486	451	8	29
TiCuSil Braze Cycle (5 min, 1143K)	427	362	19	39
TiCuSil Braze Cycle Extended (30 min, 1143K)	428	360	17	43
TiCuNi Braze Cycle (5 min, 1253K)	420	370	19	41

Elevated Temperature Mechanical Properties, AL-15
Tube with 3/8" OD and 0.03" Wall Thickness (by Sandia)

Condition	Temp. (C)	Strain Rate(1/s)	UTS (MPa)	UTS/E	R.A. (%)
Cold Worked	200	8.10E-04	384.3	3.25E-03	37.1
Cold Worked	200	7.20E-05	370.9	3.14E-03	14.6
Cold Worked	300	1.00E-02	346.7	3.07E-03	27.6
Cold Worked	300	7.10E-04	336.7	2.98E-03	28.2
Cold Worked	300	6.30E-05	314.7	2.79E-03	11.6
Cold Worked	300	5.40E-06	296.8	2.63E-03	10.7
Cold Worked	400	8.10E-03	294.7	2.77E-03	17.8
Cold Worked	400	7.90E-04	274.5	2.58E-03	17.2
Cold Worked	400	6.00E-05	262.2	2.47E-03	8.1
Annealed	200	1.10E-02	343.8	2.91E-03	38.0
Annealed	200	1.10E-03	327.7	2.77E-03	29.3
Annealed	200	1.10E-04	322.6	2.73E-03	16.9
Annealed	300	1.10E-02	300.4	2.66E-03	38.8
Annealed	300	1.10E-03	296.3	2.63E-03	14.2
Annealed	300	1.10E-04	285.2	2.53E-03	12.9
Annealed	400	1.00E-02	274.1	2.57E-03	28.6
annealed	400	8.90E-04	260.7	2.45E-03	16.6
Annealed	400	1.10E-04	253.6	2.38E-03	6.4

Glid-cop AL15 LOX

SAND88-1351, Sep. 1988

Mechanical Properties with Strain Rate of 2*10e-3/s (at Room Temp)

Condition	Yield Stress (0.2%) (MPa)	Ultimate Stress (MPa)	Max. True Stress (MPa)	True Strain (%)	Strain	R.A. (%)	Hardness Rf
As-extruded	327.0	391.7	440.0	18.8	0.172	68.9	97.9
Ticuni Braze Cycle							
(5 min at 980 C)	320.5	383.9	436.4	20.2	0.184	71.3	97.1
Extended Ticuni Braze Cycle							
(15 min at 980 C)	319.8	375.3	436.8	21.8	0.197	75.9	96.9
Long Term Annealed							
(100 hr. at 1040 C)	129.0	227.6	278.9	27.3	0.241	72.2	74.9

Mechanical Properties at High Temperature and Different Strain Rate

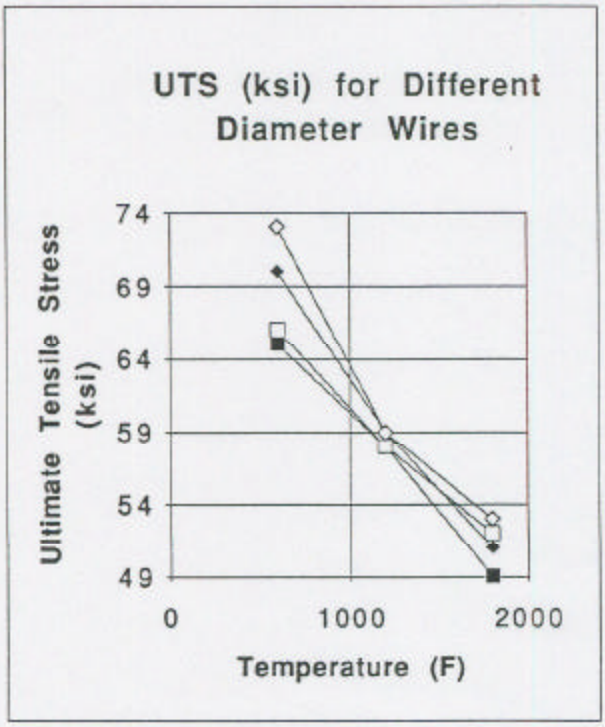
Condition	Temp. (C)	Yield stress (MPa)	Yield Stress/E	Strain Rate (1/s)	Strain	R.A. (%)
As-extruded	400	167.0	1.57E-03	2.00E-04	0.166	30.2
extended Ticuni	400	221.0	2.08E-03	2.00E-03	0.210	51.6
extended Ticuni	400	176.5	1.66E-03	2.00E-04	0.163	44.6
extended Ticuni	400	138.2	1.30E-03	2.00E-05	0.115	26.8
extended Ticuni	500	143.2	1.44E-03	2.00E-03	0.189	44.7
extended Ticuni	500	122.2	1.23E-03	2.00E-04	0.125	27.1
extended Ticuni	500	105.2	1.06E-03	2.00E-05	0.077	8.3
extended Ticuni	650	92.7	1.05E-03	2.00E-03	0.160	29.0
extended Ticuni	650	80.7	9.15E-04	2.00E-04	0.103	19.4
extended Ticuni	650	62.9	7.13E-04	2.00E-05	0.063	13.9
extended Ticuni	800	51.0	6.64E-04	2.00E-03	0.160	37.1
extended Ticuni	800	35.5	4.62E-04	2.00E-04	0.139	37.8
extended Ticuni	800	24.3	3.16E-04	2.00E-05	0.106	27.8
Coarse Grained	800	62.2	8.10E-04	2.00E-03	0.114	31.4
Coarse Grained	800	42.7	5.56E-04	2.00E-05	0.092	27.8

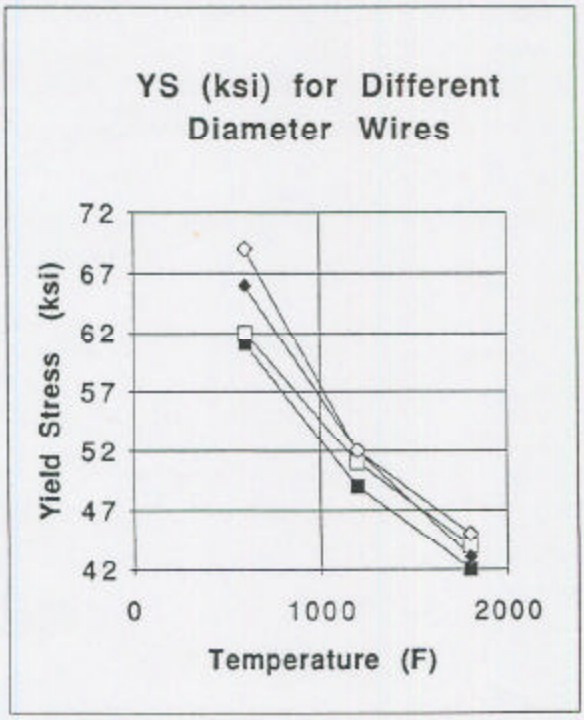
Glidcop Mechanical Properties (AL-15)

SCM Metal Products, Inc. Technical Data

Glidcop Mechanical Properties (Al-15 wire)

Diameter (inch)	Cold work (%)	Condition (Anneal Temp F)	UTS (ksi)	0.2% YS (ksi)	Elongation (%) in 10"	YS/UTS (%)	YS Annealed/ YS Drawn (%)
0.1	99.2	As Drawn	72	68	2	95	
		600	65	61	3	94	90
		1200	58	49	11	88	72
		1800	49	42	12	85	62
0.05	99.8	As Drawn	76	72	2	95	
		600	66	62	3	94	86
		1200	58	51	10	88	71
		1800	52	44	11	85	61
0.02	99.9	As Drawn	87	83	2	95	
		600	70	66	3	94	80
		1200	59	52	9	88	63
		1800	51	43	10	85	52
0.014	99.9	As Drawn	88	84	1	95	
		600	73	69	3	94	82
		1200	59	52	8	88	62
		1800	53	45	9	85	54



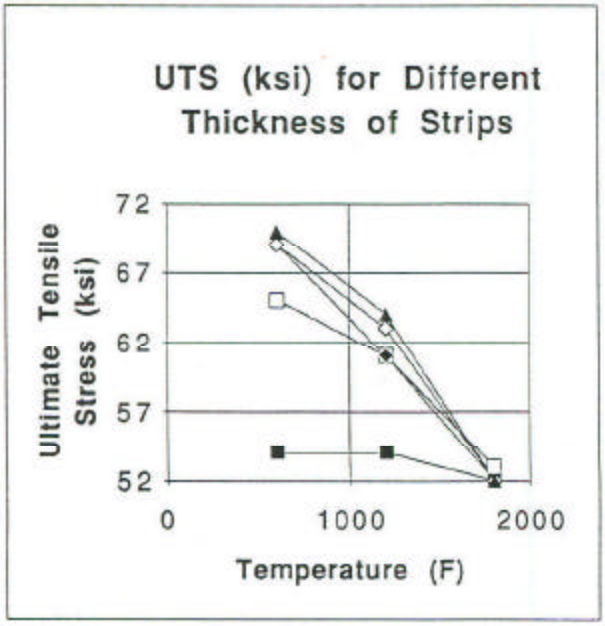


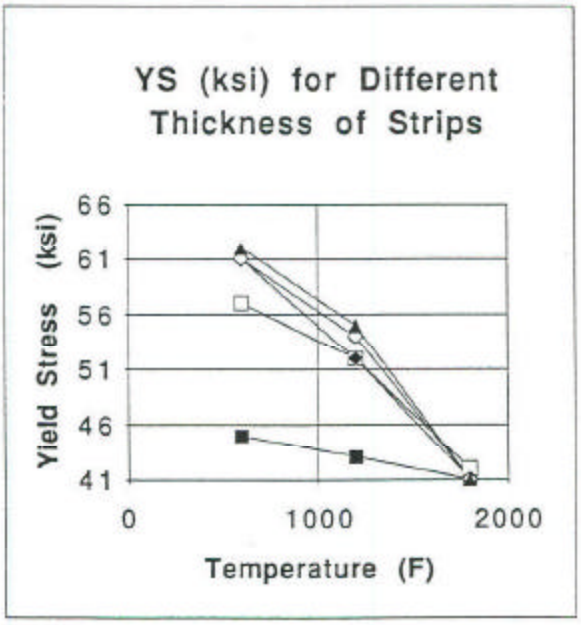
Glidcop Mechanical Properties (AL-15)

SCM Metal Products, Inc. Technical Data

Glidcop Mechanical Properties (Al-15 Strip)

Thickness (inch)	Cold work (%)	Condition (Anneal Temp F)	UTS (ksi)	0.2% YS (ksi)	Elongation (%) in 2"	YS/UTS (%)	YS Annealed/ YS Cold Rooled
0.25	0	As Extruded	55	46	6	82	
		600	54	45	26	83	98
		1200	54	43	28	80	93
		1800	52	41	30	78	89
0.09	64	As Rooled	70	66	7	95	
		600	65	57	13	88	86
		1200	61	52	21	86	79
		1800	53	42	22	79	64
0.05	80	As Rooled	73	69	6	95	
		600	69	61	11	88	88
		1200	61	52	20	86	75
		1800	52	41	22	79	59
0.03	88	As Rooled	74	70	6	95	
		600	69	61	11	88	87
		1200	63	54	20	86	77
		1800	52	41	21	79	59
0.01	88	As Rooled	88	84	4	95	
		600	70	62	8	88	74
		1200	64	55	16	86	65
		1800	52	41	18	79	49



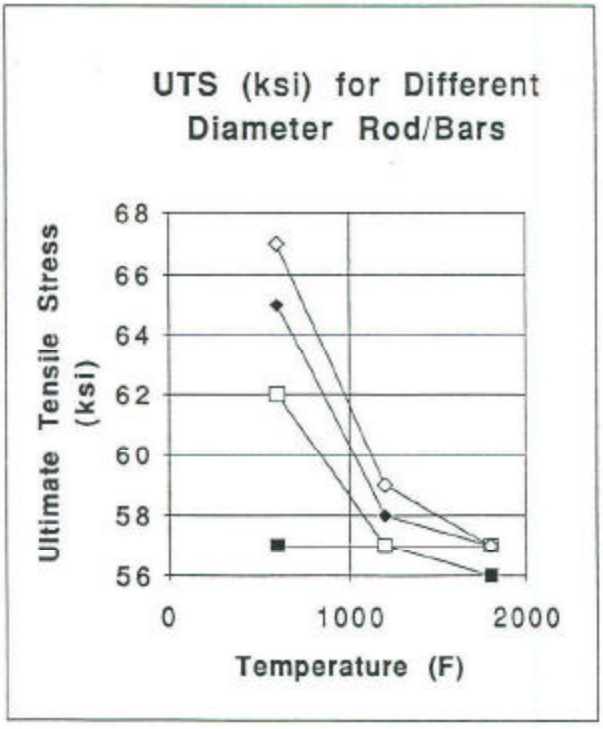


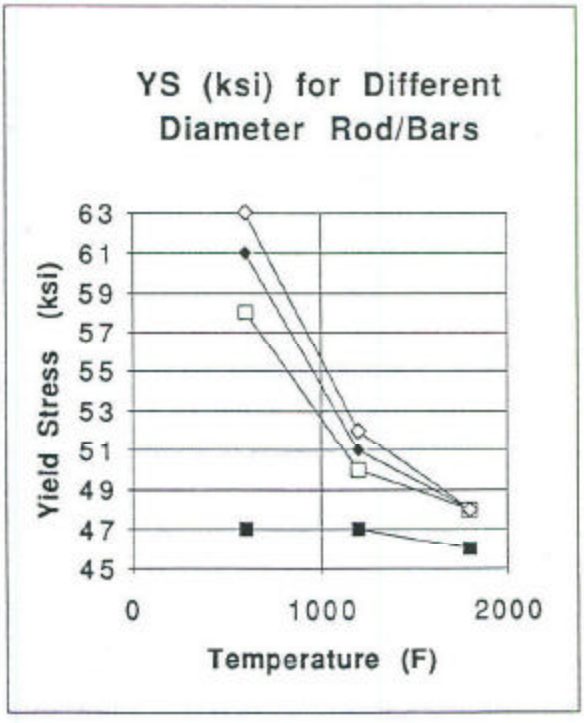
Glidcop Mechanical Properties (AL-15)

SCM Metal Products, Inc. Technical Data

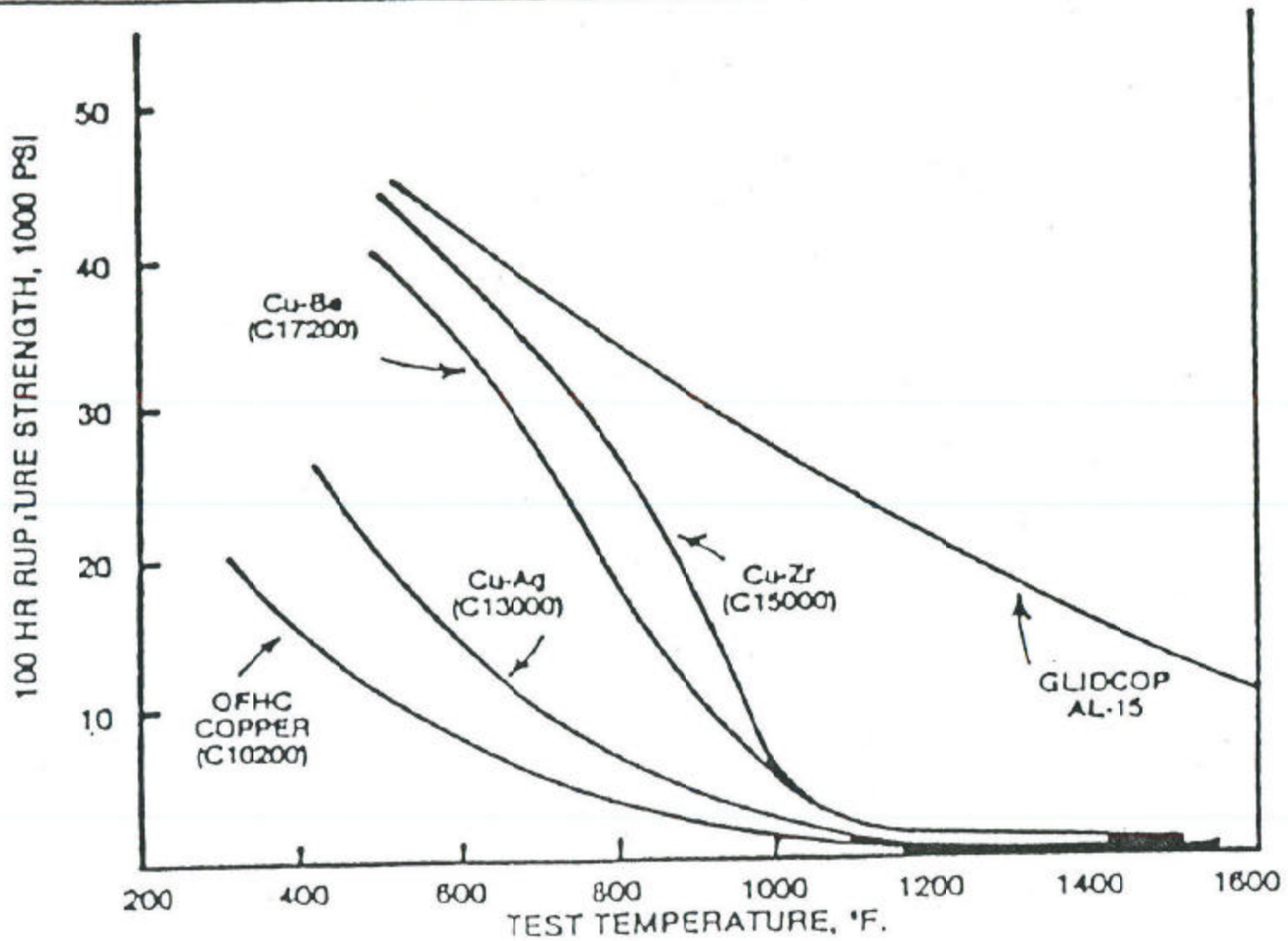
Glidcop Mechanical Properties (Al-15 Rod/Bar)

Diameter (inch)	Cold work (%)	Condition (Anneal Temp F)	UTS (ksi)	0.2% YS (ksi)	Elongation (%) in 0.54"	YS/UTS (%)	YS Annealed/ YS Drawn (%)
1.125	0	As Extruded	57	47	27	82	
		600	57	47	27	82	100
		1200	57	47	28	82	100
		1800	56	46	29	82	98
0.750	55	As Drawn	62	59	24	95	
		600	62	58	24	94	98
		1200	57	50	27	88	85
		1800	57	48	27	85	81
0.500	80	As Drawn	66	63	21	95	
		600	65	61	21	94	97
		1200	58	51	25	88	81
		1800	57	48	27	85	76
0.275	94	As Drawn	72	68	19	95	
		600	67	63	19	94	93
		1200	59	52	24	88	76
		1800	57	48	27	85	71





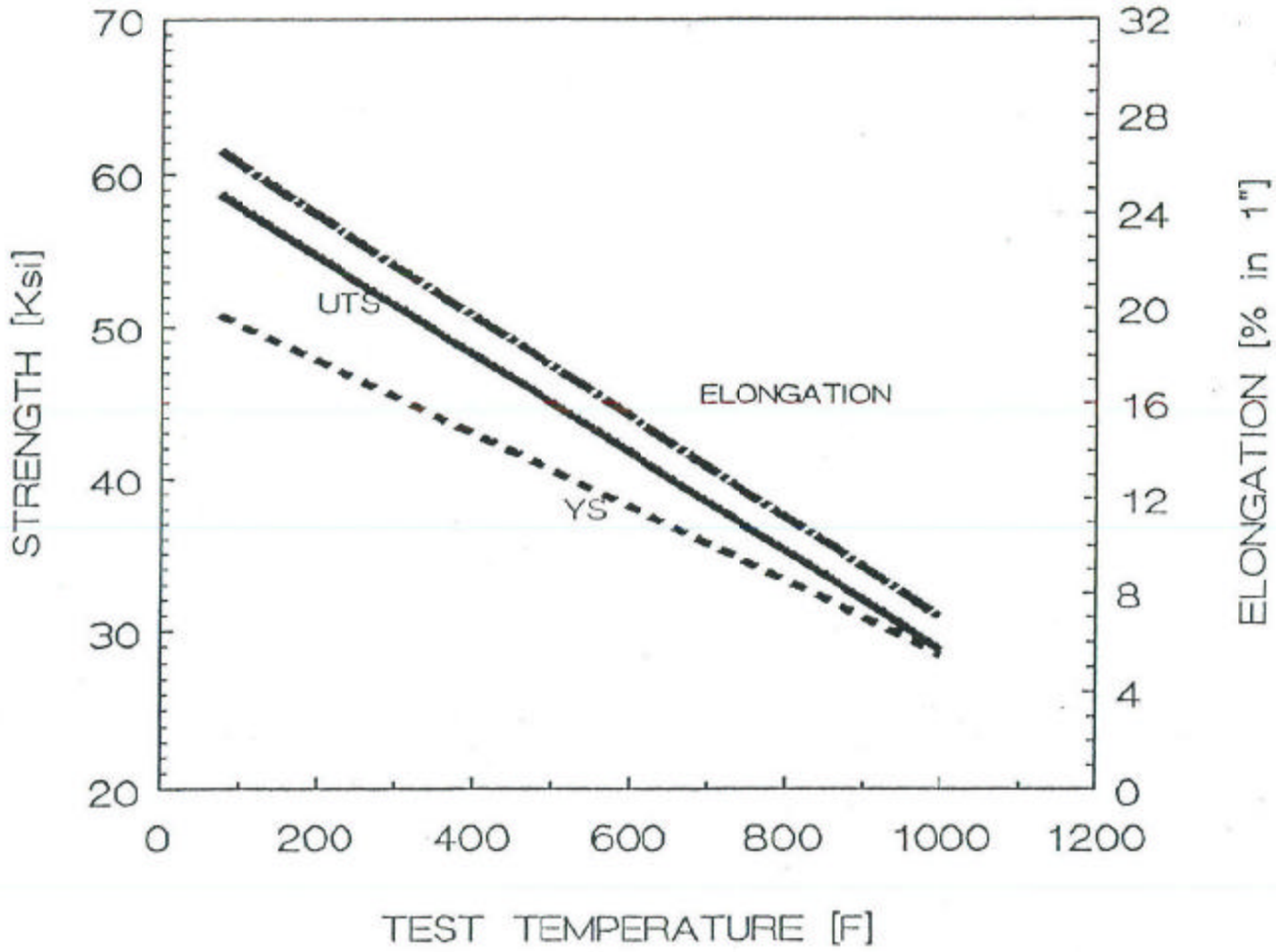
ELEVATED TEMPERATURE STRESS RUPTURE PROPERTIES OF GLIDCOP AL-15



SCM Tech Data

ELEVATED TEMPERATURE PROPERTIES

GlidCop AL-15 LOX EXTRUDED BAR

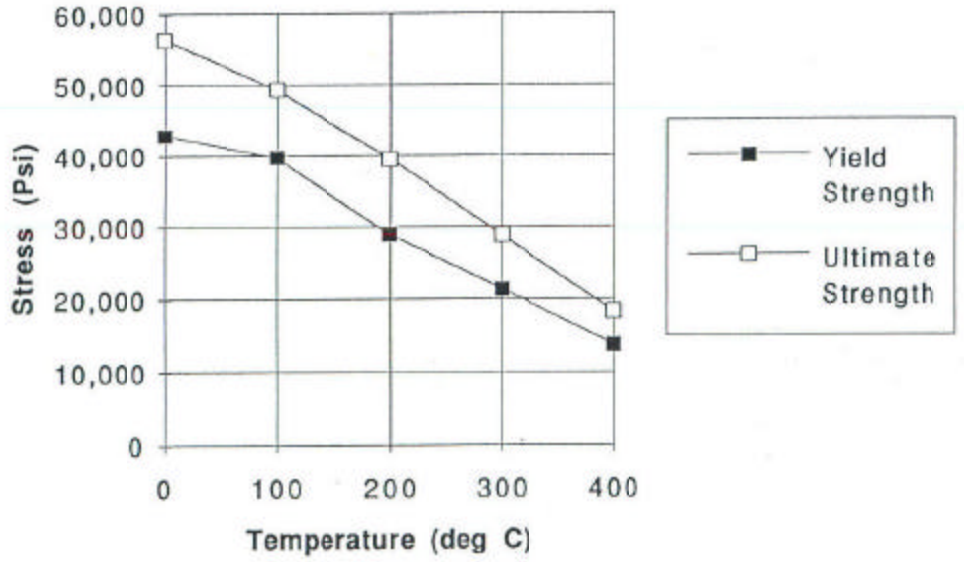


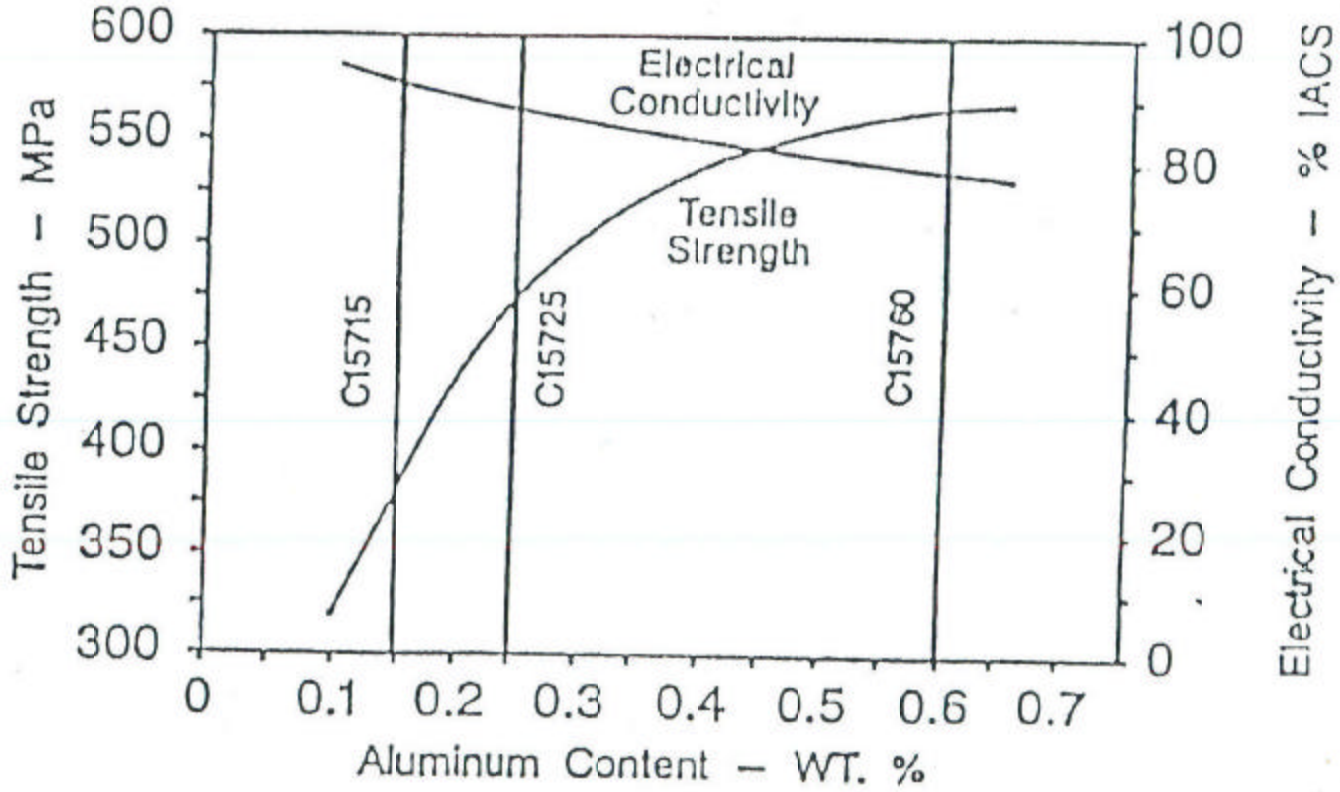
2 December 91/JDT

Glid_COP AL-15 LOX
ASTM E8
ASTM E21

JML Feb, 1991

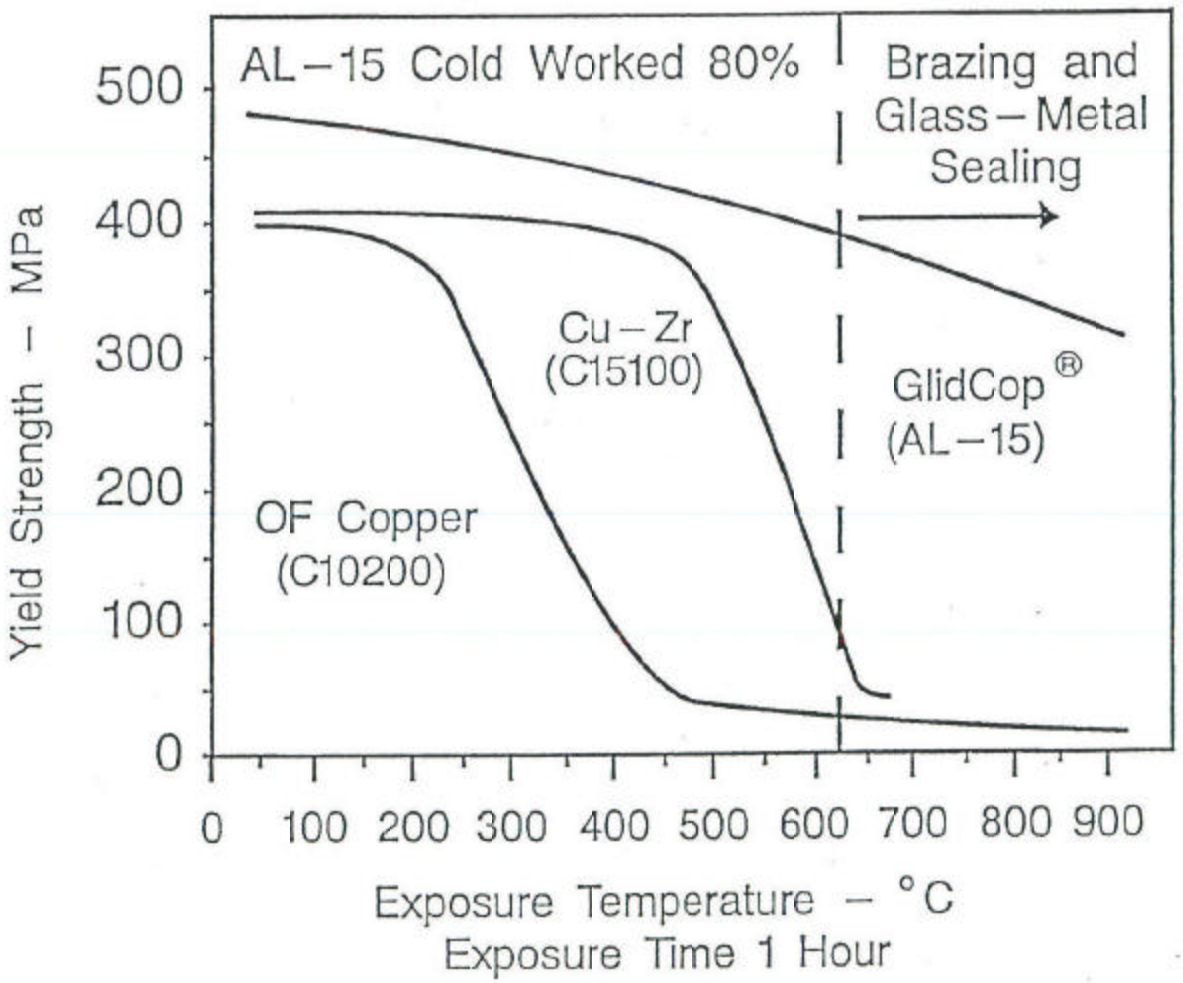
Bar Size	Test Temp. C	0.2% Yield Strength Psi	Jltimate Tensile Strength Psi	% Elong. in 4D	%RA
0.2500	0	42,800	56,400	26.4	61.5
0.2501	100	39,700	49,300	29.3	48.2
0.2497	200	28,900	39,600	19.2	22.3
0.2498	300	21,400	28,800	9.3	13.0
0.2500	400	13,800	18,300	3.9	10.8





Tailored Properties of GlidCop DSC

SCM



Softening resistance of GlidCop AL-15 versus OF Copper and Zirconium Copper.
(Note: Properties measured at room temperature after exposure to elevated temperatures).

SCM

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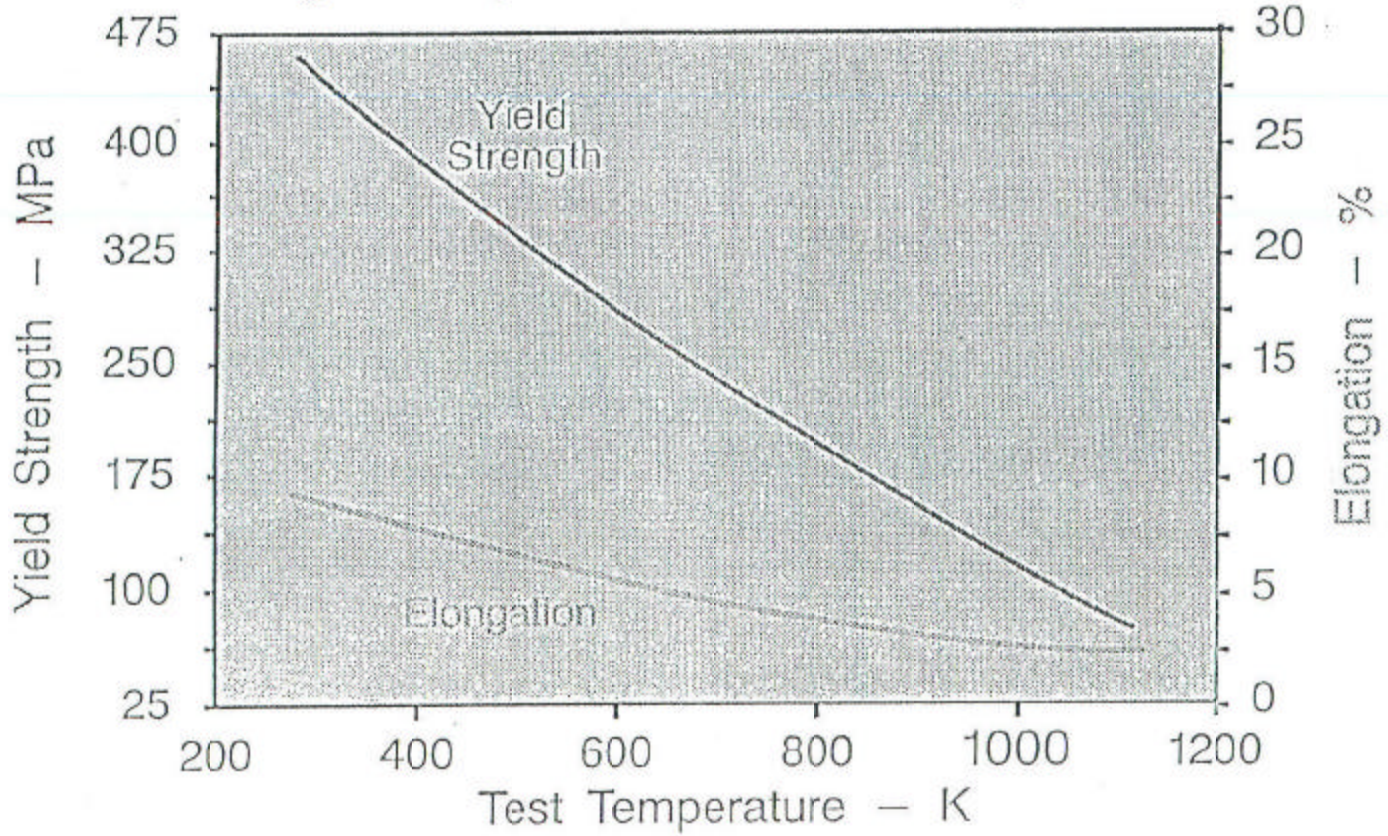
Properties of GlidCop®

SCM METAL PRODUCTS, INC.
2601 Week Drive
Research Triangle Park,
N. Carolina 27709 U.S.A.
Tel. 919-544-8090
FAX: 919-544-7996
Telex: 196-072 (SCM MTL UT)

ROD & BAR: AL–15 7mm Dia. (94% Cold Work)

High Temperature Tensile Properties



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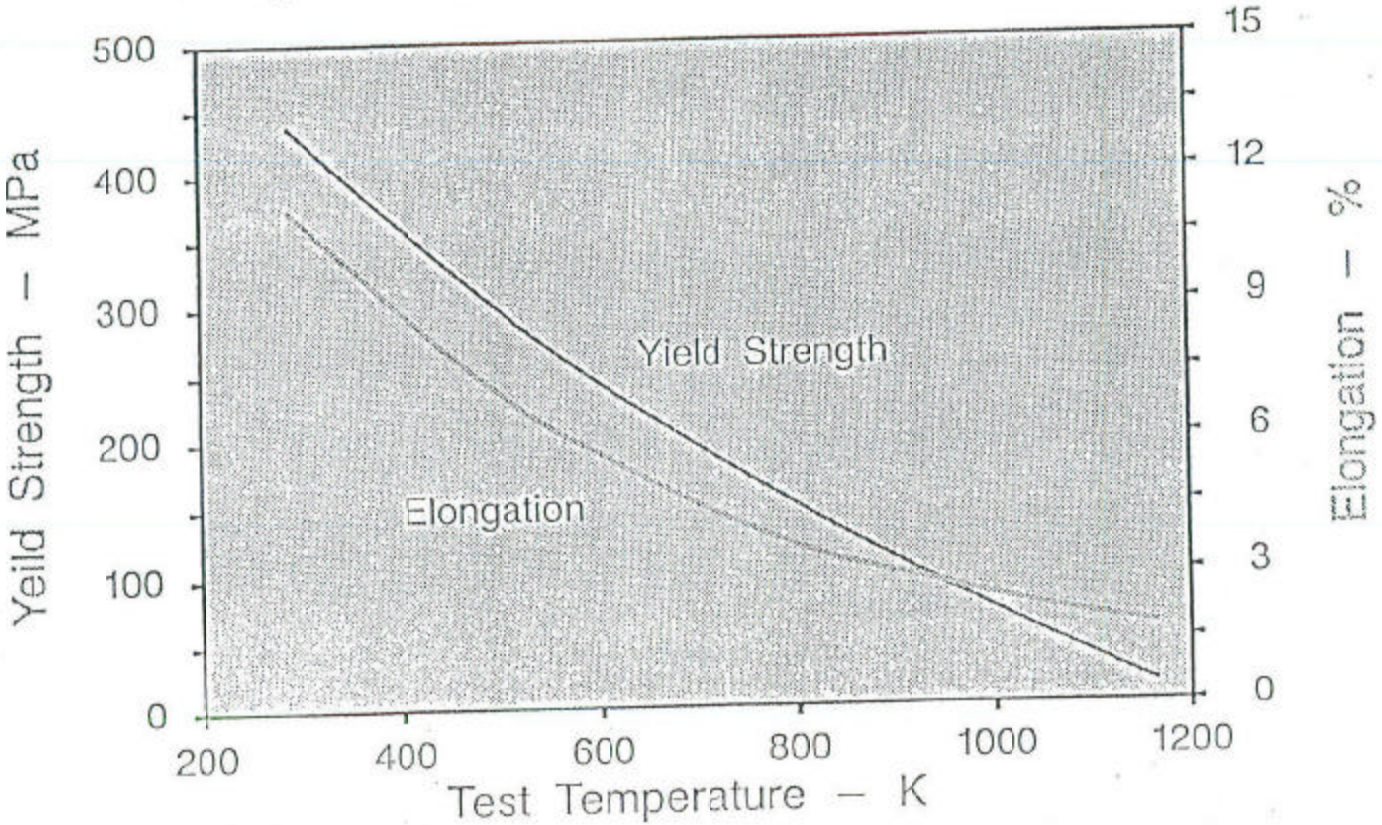
SCM METAL PRODUCTS, INC.
2601 Weck Drive
Research Triangle Park,
N. Carolina 27709 U.S.A.
Tel. 919-544-8090
FAX: 919-544-7996
Telex: 196-072 (SCM MTL UT)

Properties of GlidCop®

PLATE: AL–15 12.5 mm Thick

High Temperature Tensile Properties



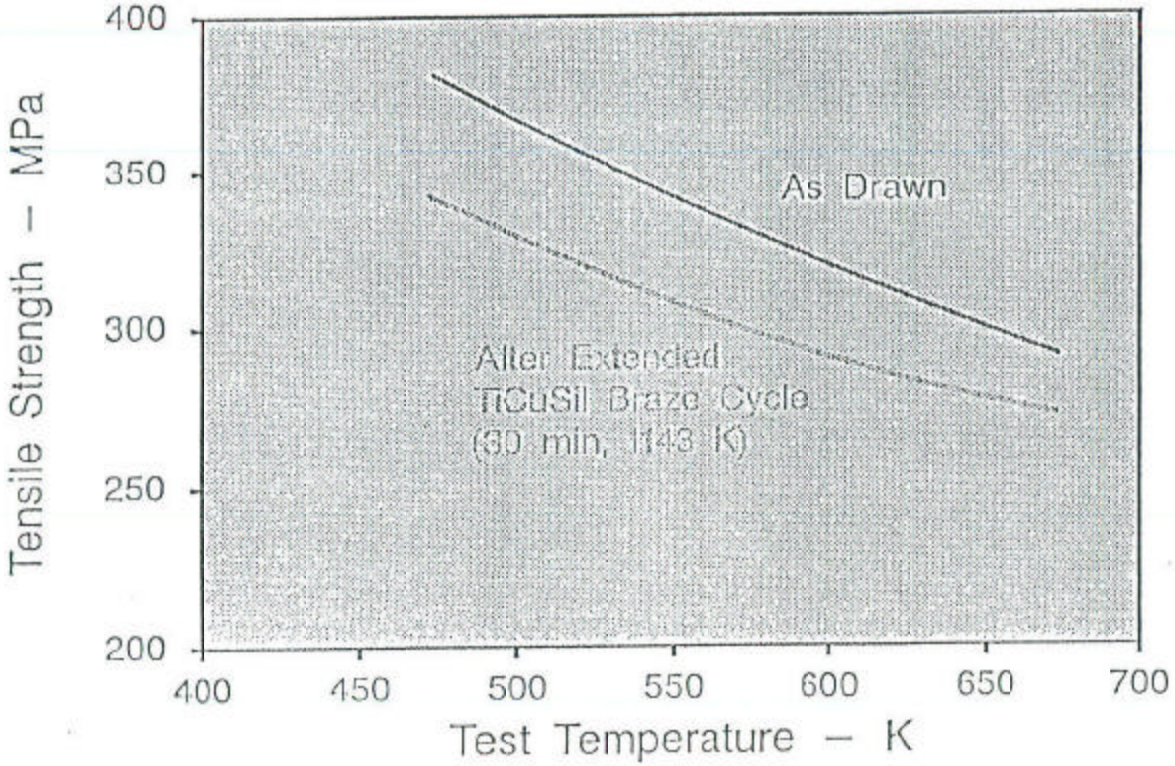
Slide: A-34 Opid: ProShows Inc. Job #: 1045 DDS: 499 size: 1558 Tue Nov 7 09:36:03 1989

Properties of GlidCop®

SCM METAL PRODUCTS, INC.
2601 Weck Drive
Research Triangle Park,
N. Carolina 27709 U.S.A.
Tel. 919-544-8090
FAX: 919-544-7996
Telex: 196-072 (SCM MTL UT)

TUBE: AL–15 9.5 mm OD, .76 mm Wall

High Temperature Tensile Strength



Courtesy: Sandia National Laboratories

Slide: B-37 Opid: ProShows Inc. Job #: 1045 DDS: 499 size: 1824 Mon Nov 6 09:48:54 1989

Properties of GlidCop®

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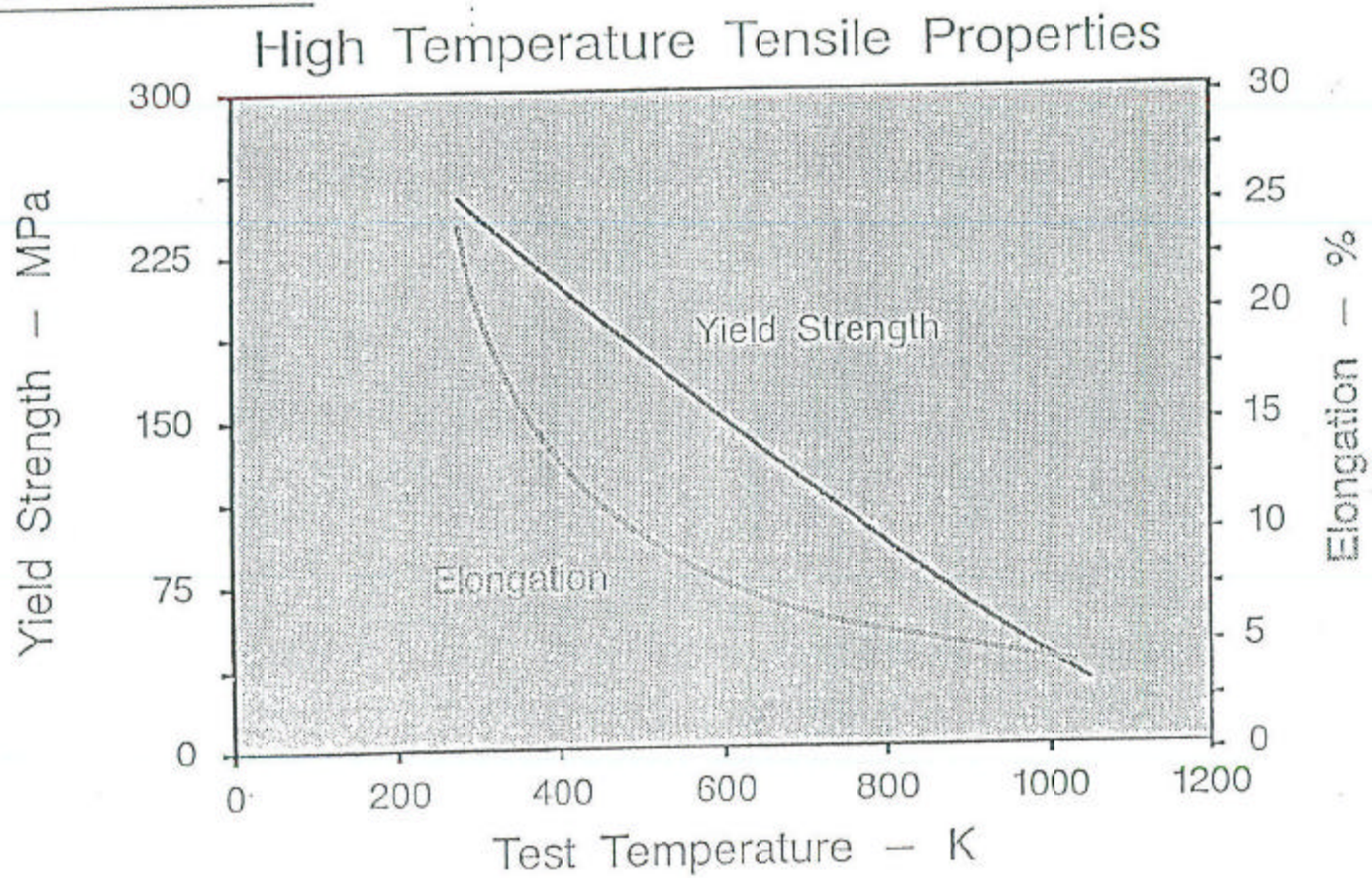
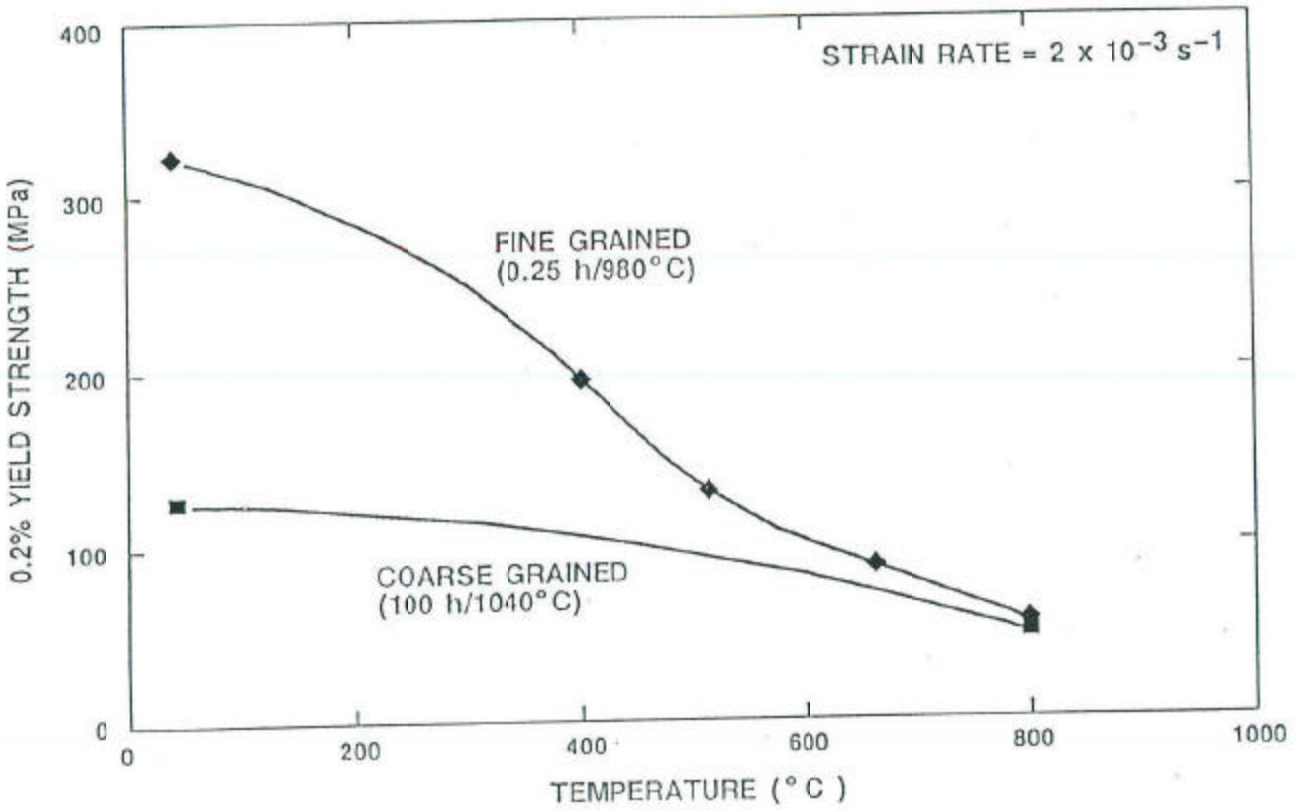
FAX: 919-544-7996
Telex: 196-072 (SCM MTL UT)

LARGE SHAPES: AL–15



GLIDCOP Al–15 LOW OXYGEN GRADE OXIDE DISPERSION STRENGTHENED COPPER YIELD STRESS VS. TEMPERATURE DATA



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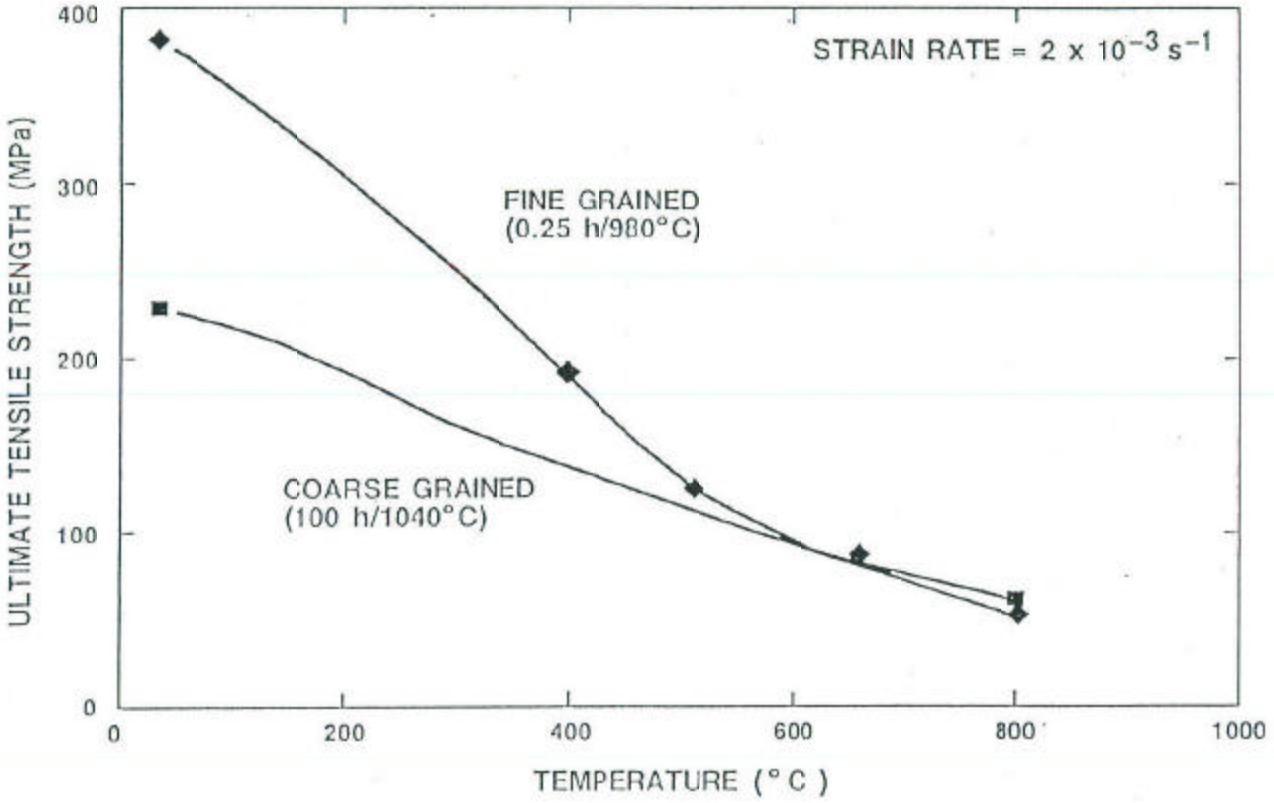
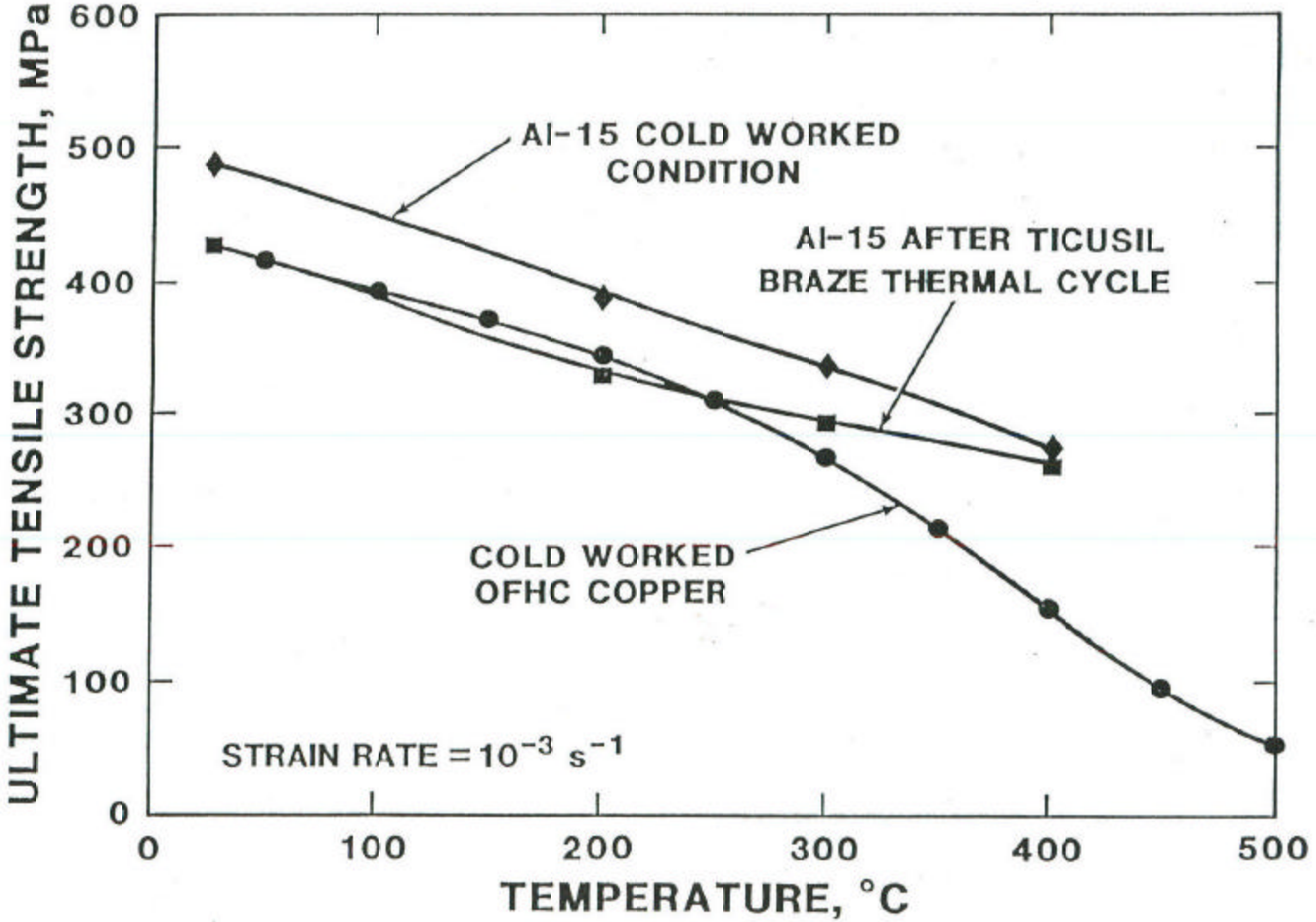
GLIDCOP Al–15 LOW OXYGEN GRADE
OXIDE DISPERSION STRENGTHENED COPPER
ULTIMATE TENSILE STRENGTH VS. TEMPERATURE DATA



Sandia

TENSILE STRESS VS. TEMPERATURE
DISPERSION STRENGTHENED AND OFHC COPPER



The effect of temperature on the tensile strength of cold worked Al-15, Al-15 after an extended (30 min. at 870°C) Ticusil braze thermal cycle, and cold worked OFHC copper. OFHC copper data from reference 15. All data shown are for standard tensile testing strain rates, approximately 10^{-3} s^{-1}.

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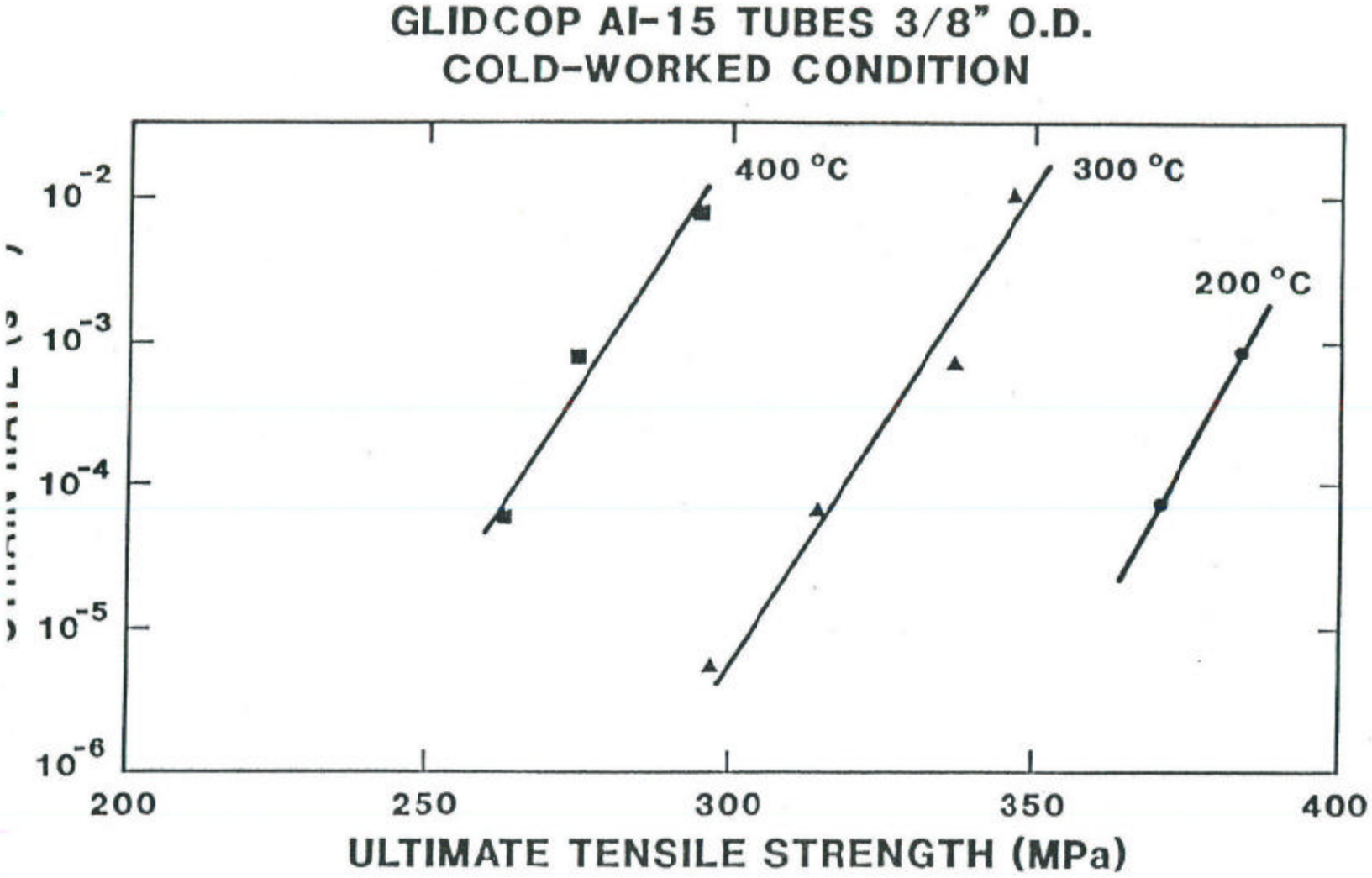
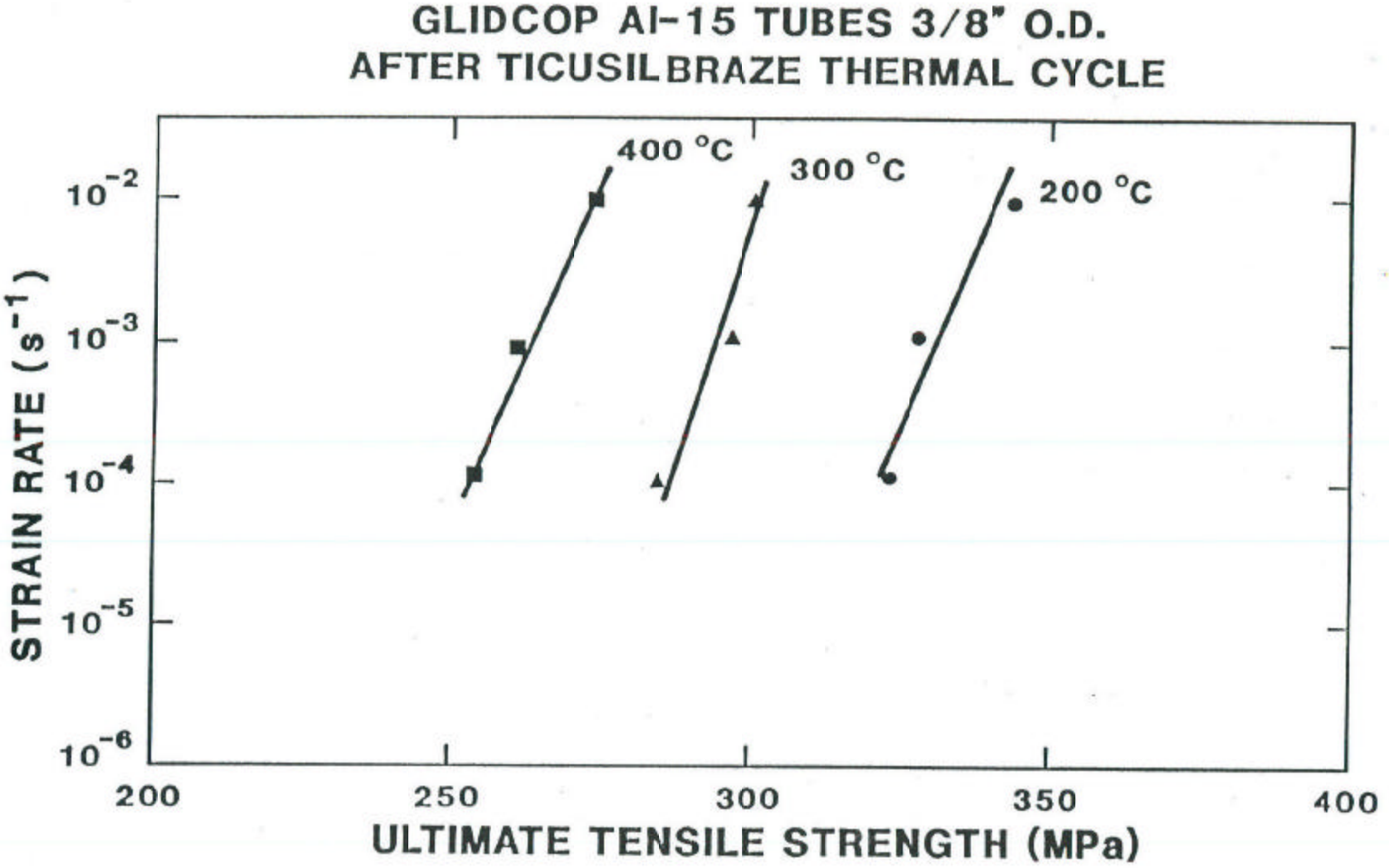


The effect of strain rate and temperature on the tensile strength of cold worked Al-15.



The effect of strain rate and temperature on the tensile strength of Al-15 subjected to an extended (30 min. at 870°C) Ticusil braze thermal cycle.

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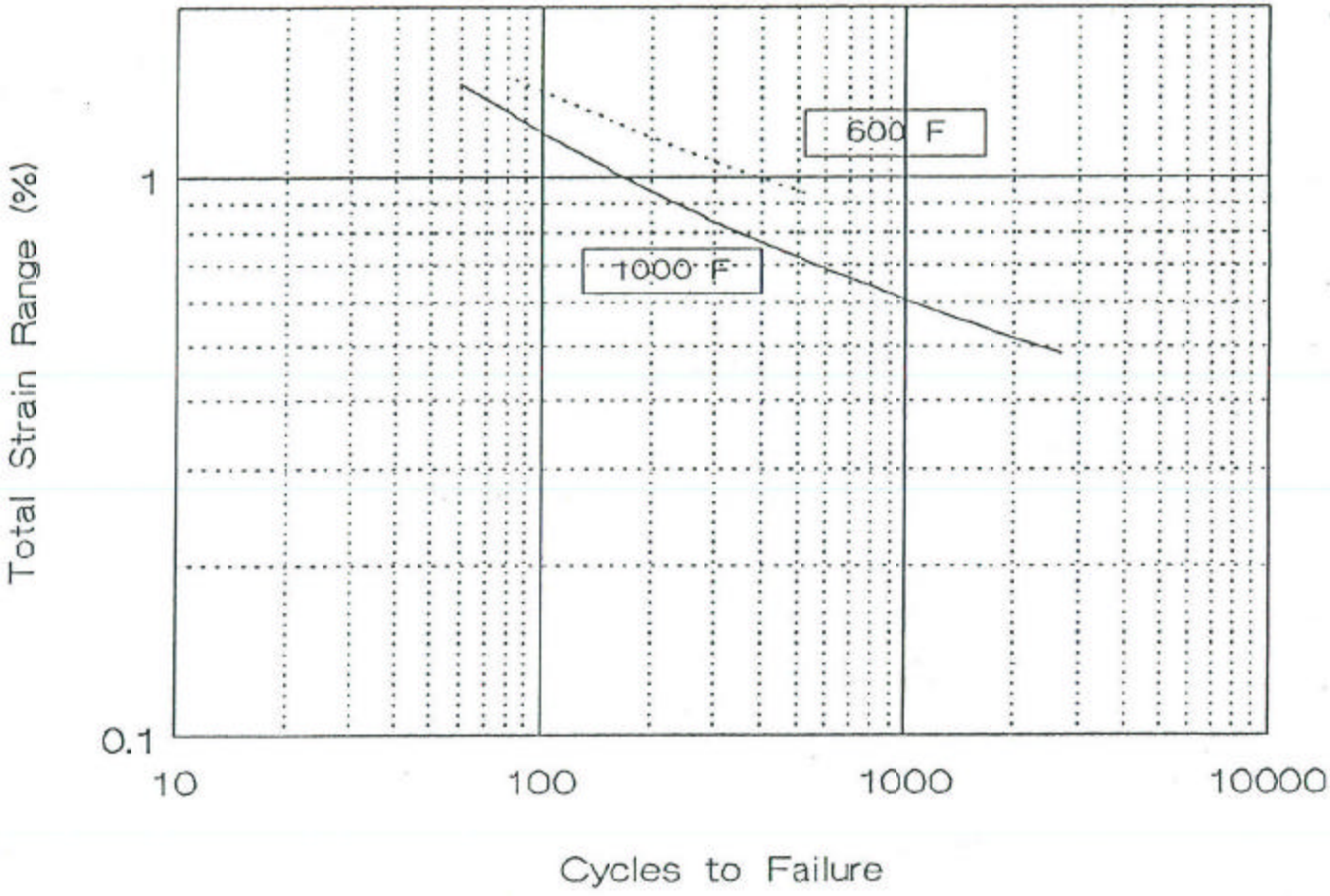
GlidCop AL-15 Low Cycle Fatigue

Tens/~~Tens~~ Compression, 10CPM, Strain Control R=-1.0



27 November 91/JDT

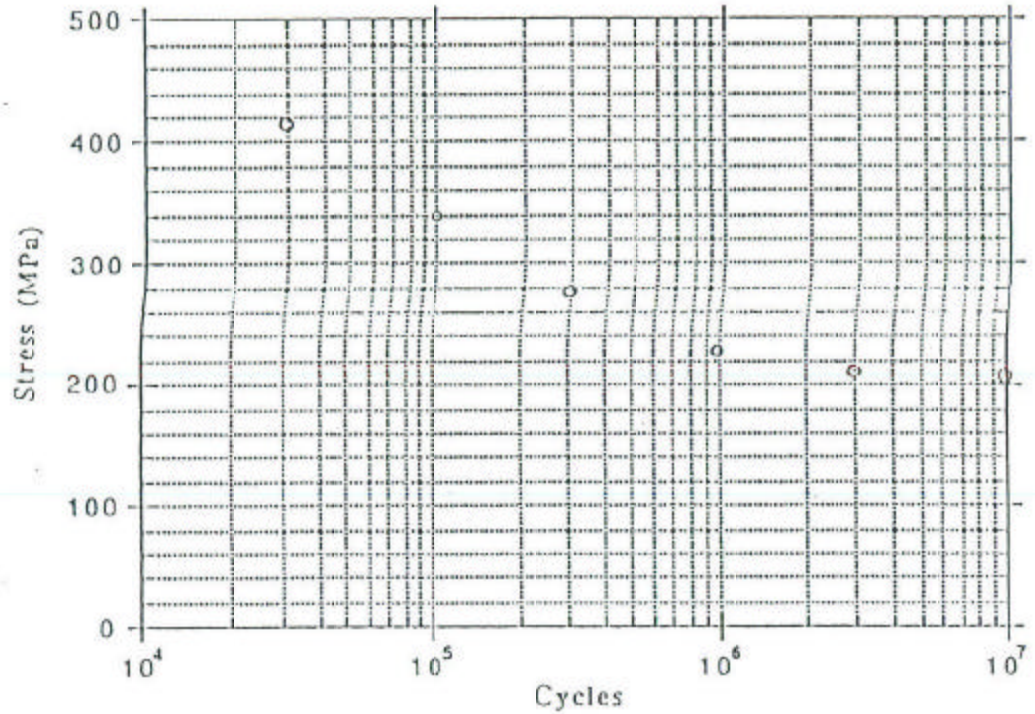


Figure 15 **Fatigue Data for GlidCop Grade AL-15**

Adian 9-11-91

Slide: A-31 Opid: ProShows Inc. Job #: 1045 DDS: 499 size: 1050 Mon Nov 6 09:20:21 1989

Properties of GlidCop®

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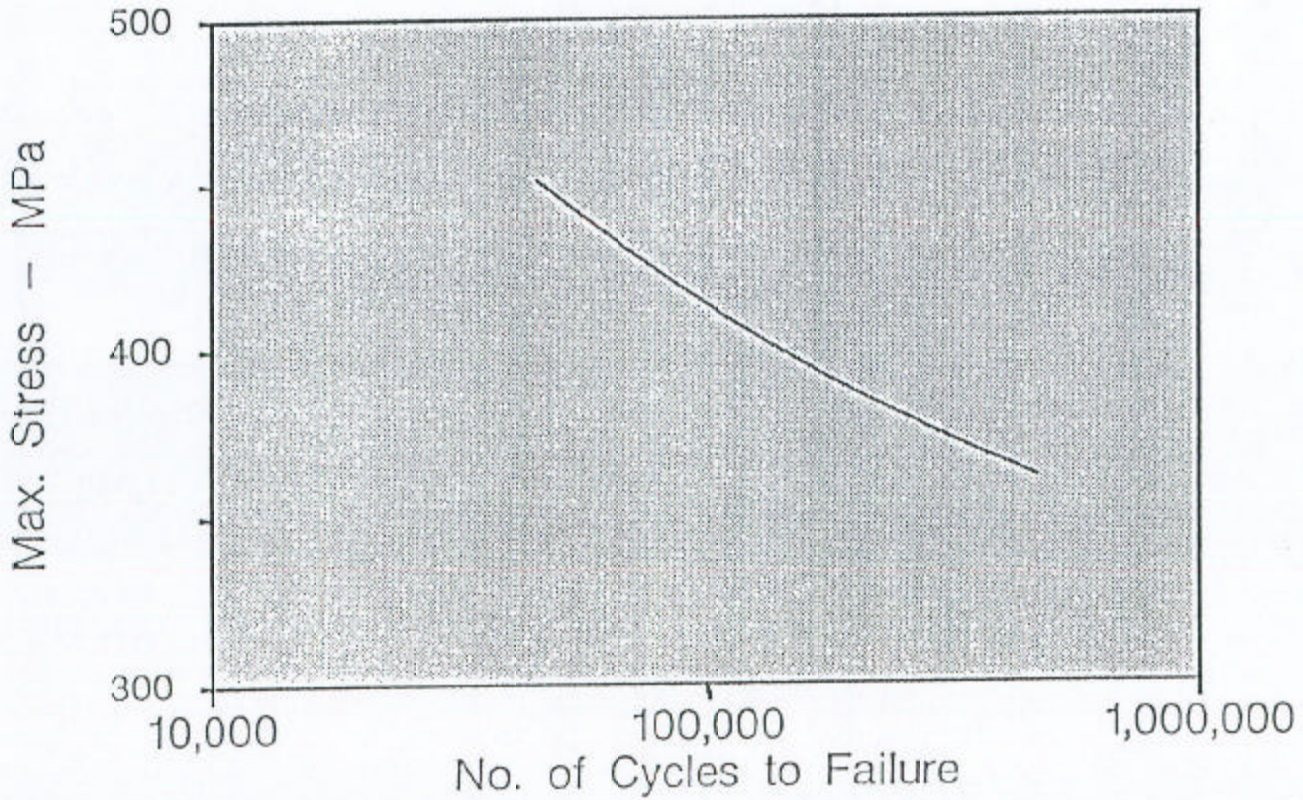
Telex: 196-072 (SCM MTL UT)

PLATE: AL–15 12.5 mm Thick

RT Fatigue Properties



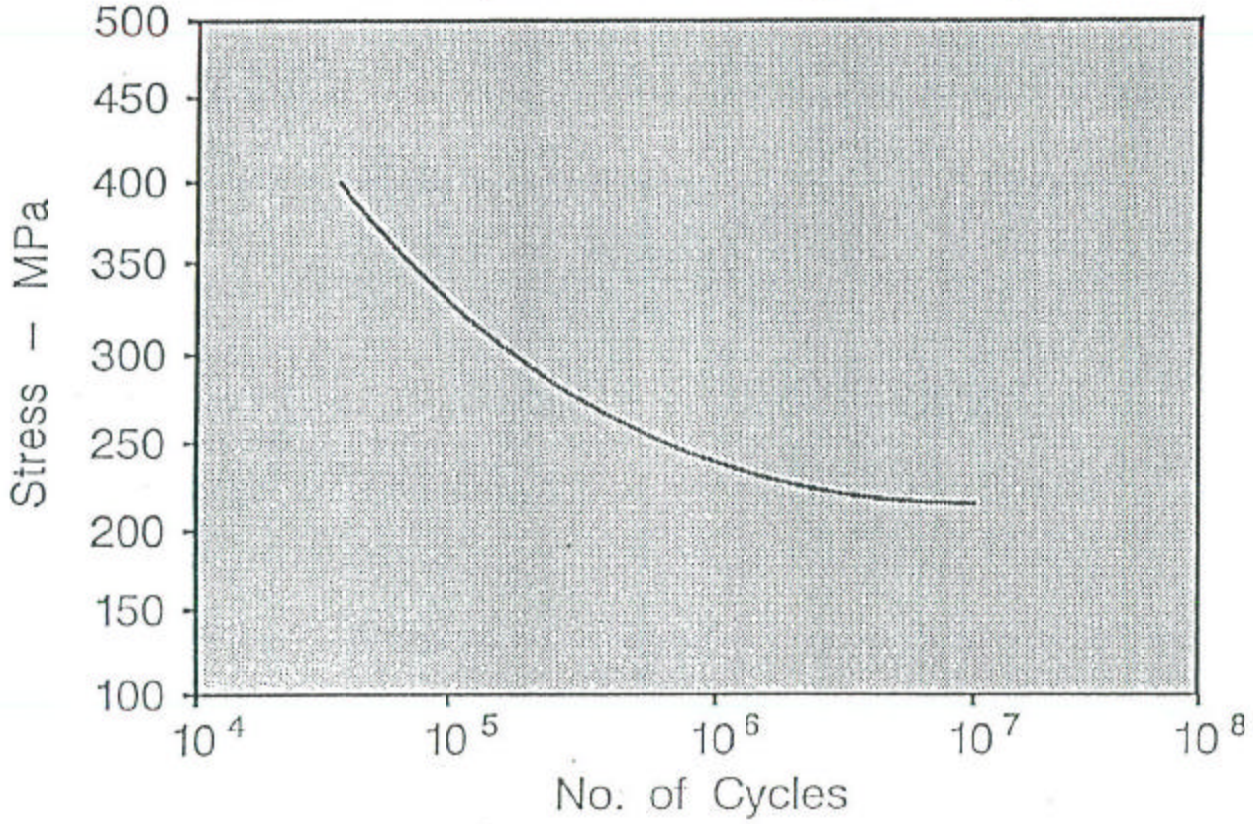
Courtesy: Massachusetts Institute of Technology

Slide: A-24 Opid: ProShows Inc. Job #: 1045 DDS: 499 size: 1382 Mon Nov 6 10:42:26 1989

Properties of GlidCop®

ROD & BAR: AL–15 7mm Dia. (94% Cold Work)

Room Temperature Fatigue Properties



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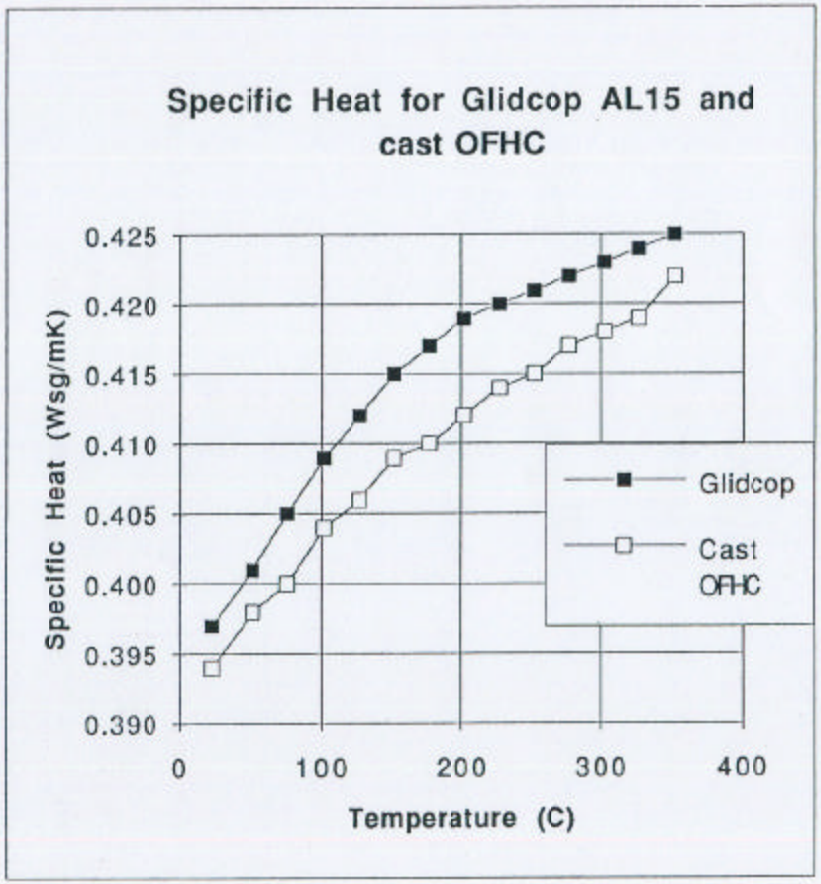
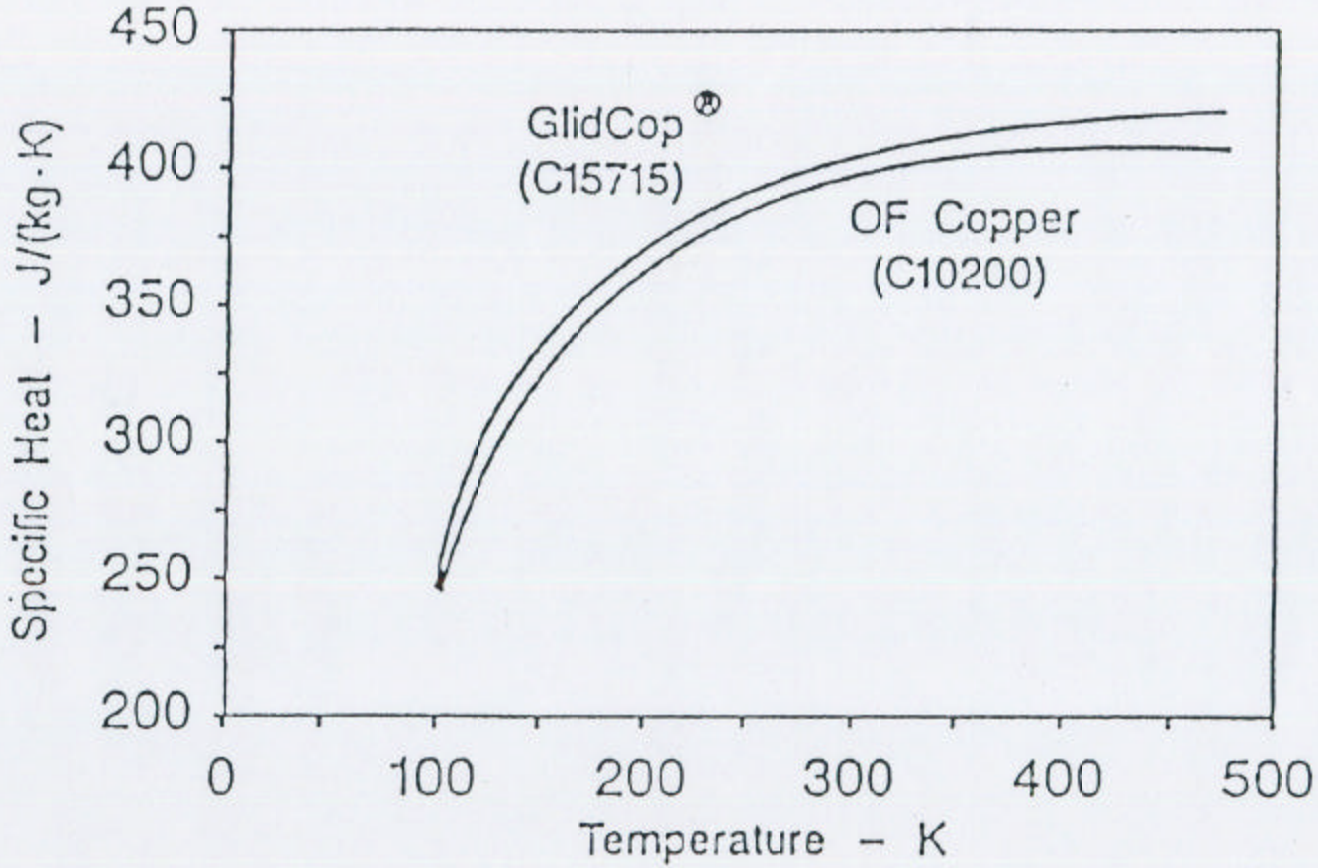
N. Carolina 27709 U.S.A.
Tel. 919-544-8090
FAX: 919-544-7996
Telex: 196-072 (SCM MTL UTD)

Glid-COP AL-15 and OFHC Thermophysical Properties

TPRL 1068, Jul. 1991

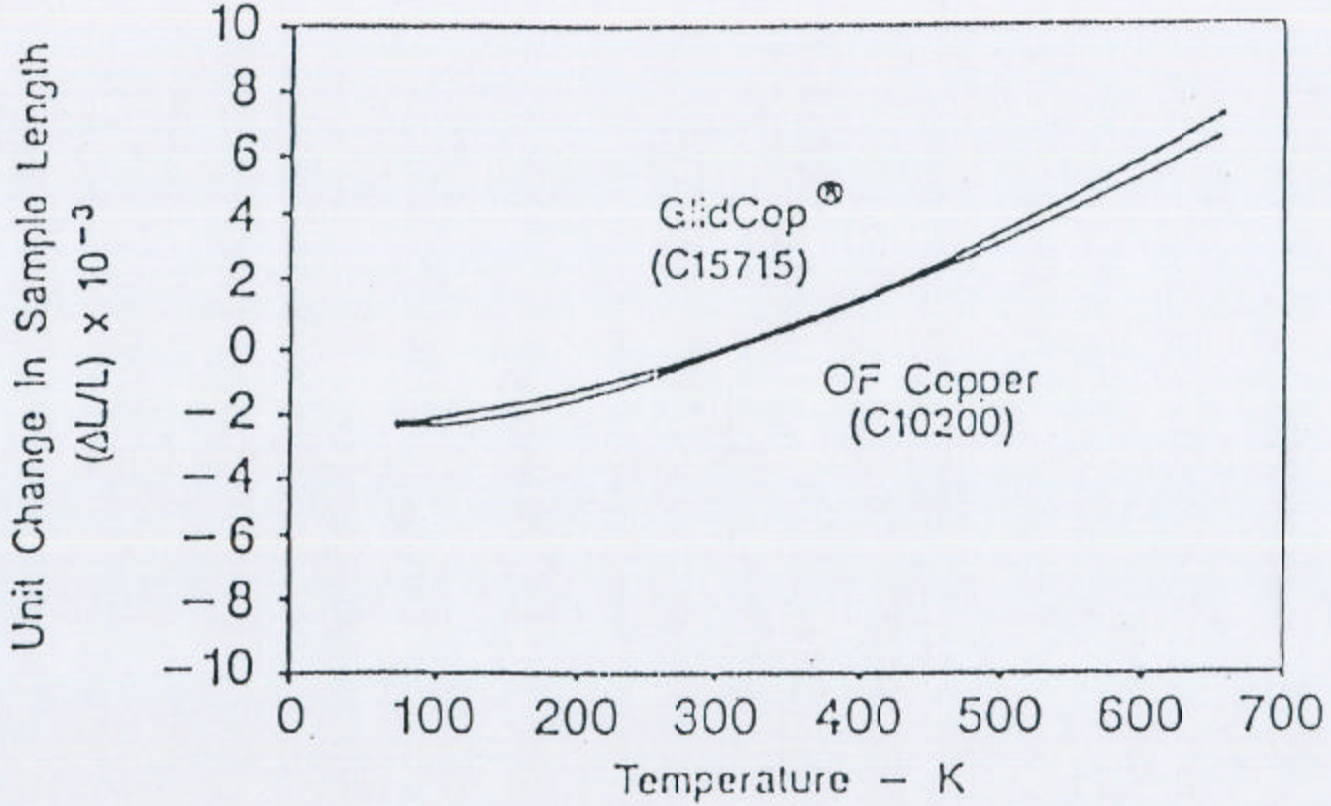
	Specific Heat	
Temperature (C)	Glid-cop	Cast OFHC
23	0.397	0.394
52	0.401	0.398
77	0.405	0.400
102	0.409	0.404
127	0.412	0.406
152	0.415	0.409
177	0.417	0.410
202	0.419	0.412
227	0.420	0.414
252	0.421	0.415
277	0.422	0.417
302	0.423	0.418
327	0.424	0.419
352	0.425	0.422





Specific Heat of GlidCop AL-15
vs OF Copper

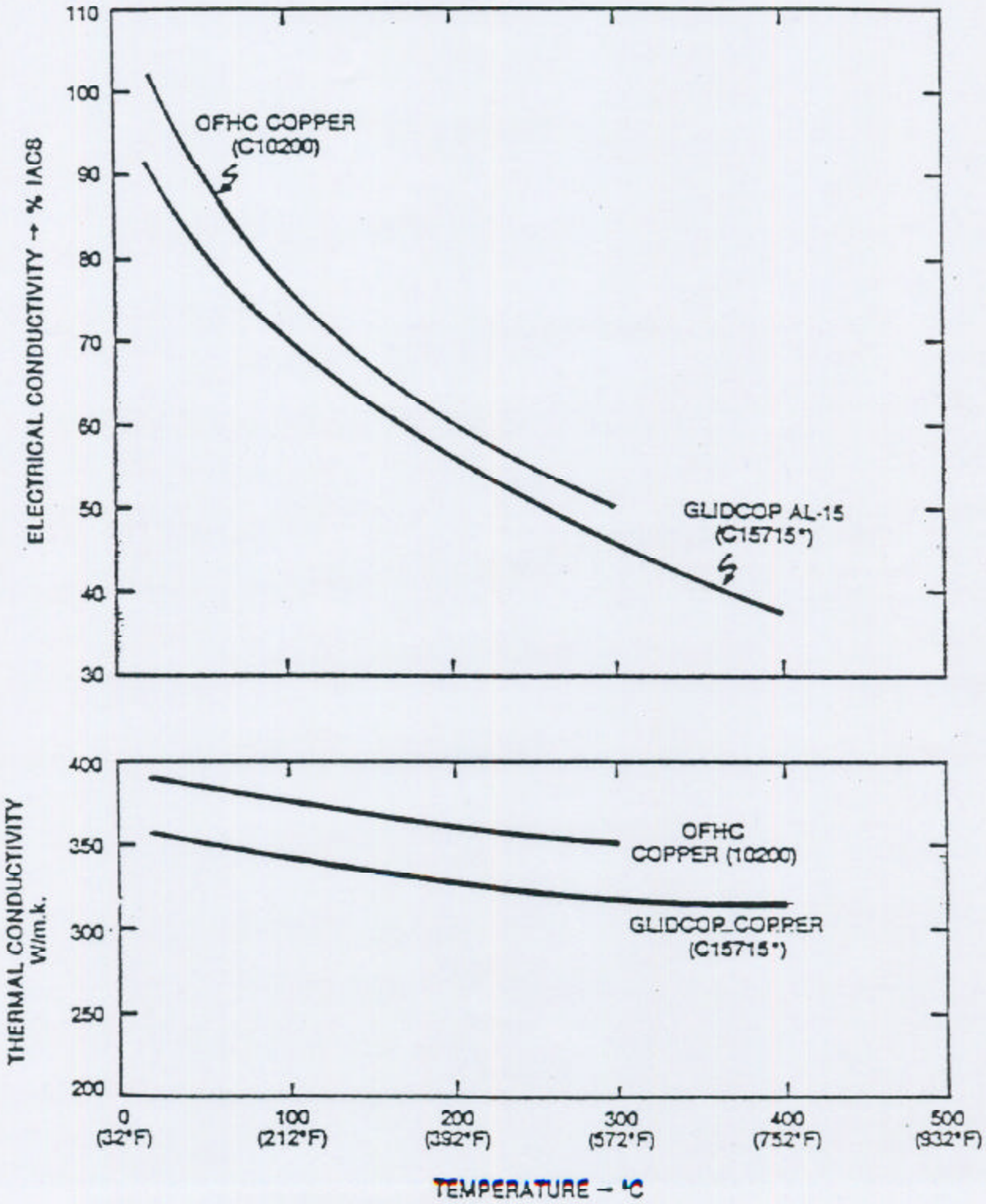
SCM



Thermal Expansion of GlidCop
AL-15 vs OF Copper

SCM

ELEVATED TEMPERATURE ELECTRICAL AND THERMAL CONDUCTIVITIES



*This number is pending the approval of the Copper Development Association.

Glid-cop AL-15 and Cast OFHC Thermophysical Properties

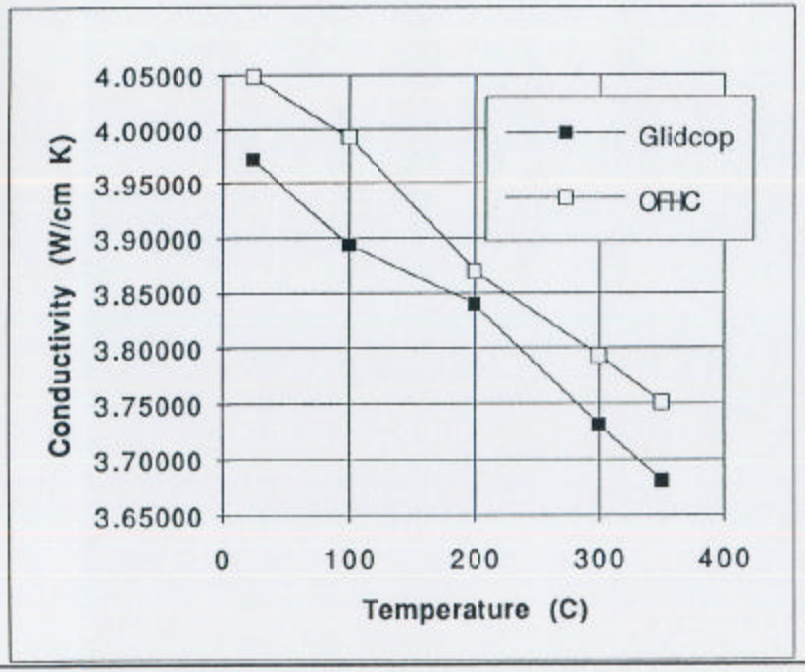
TPRL 1068, JUL 1991

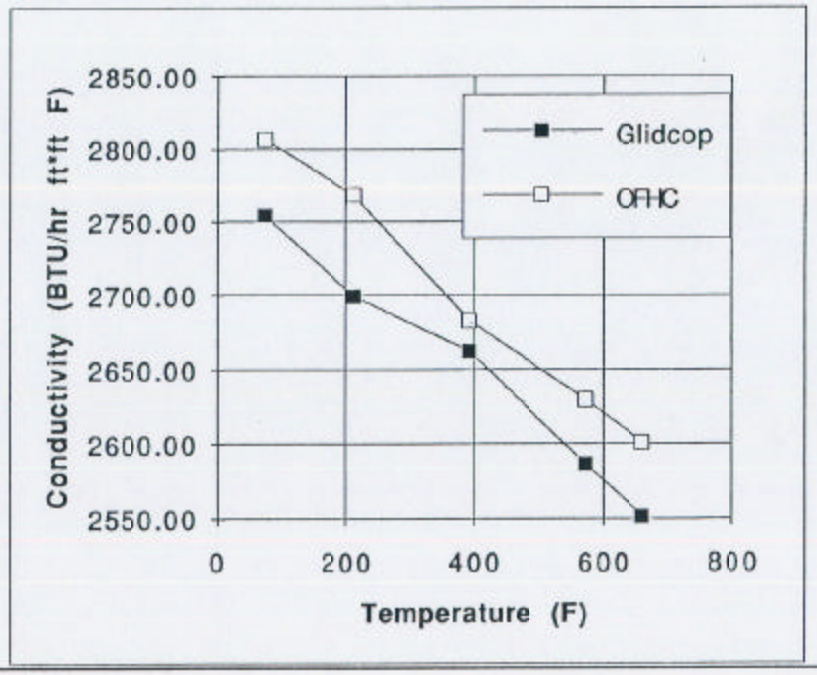
Thermal Conductivity (W/cm K)

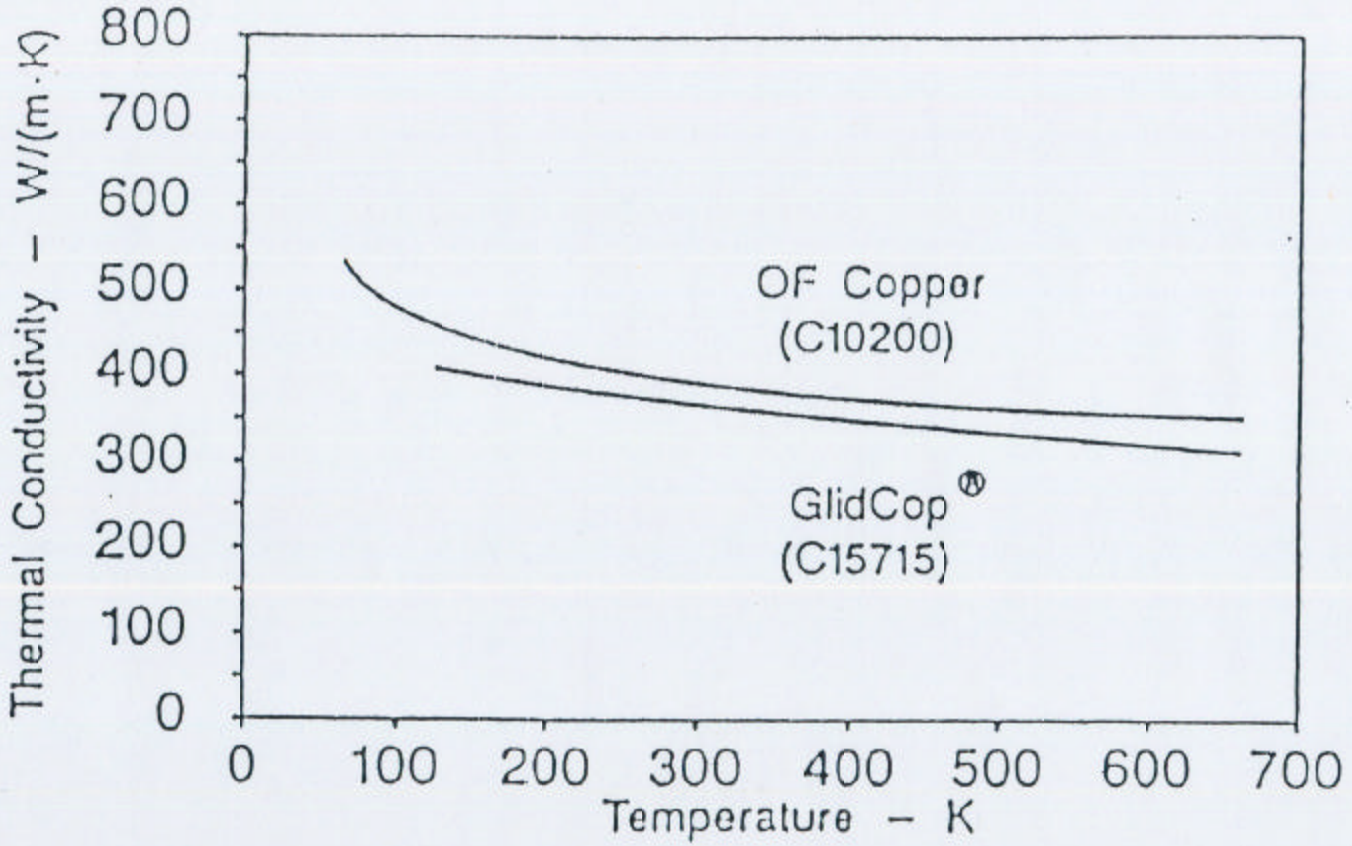
Temp (C)	Glid-cop	Cast OFHC
23	3.97289	4.04847
100	3.89376	3.99273
200	3.84054	3.87004
300	3.73110	3.79368
350	3.68100	3.75182

Thermal Conductivity (BTU/hr ft*ft F)

Temp (F)	Glid-cop	Cast OFHC
73.4	2754.59	2806.99
212	2699.73	2768.34
392	2662.82	2683.28
572	2586.95	2630.33
662	2552.21	2601.31

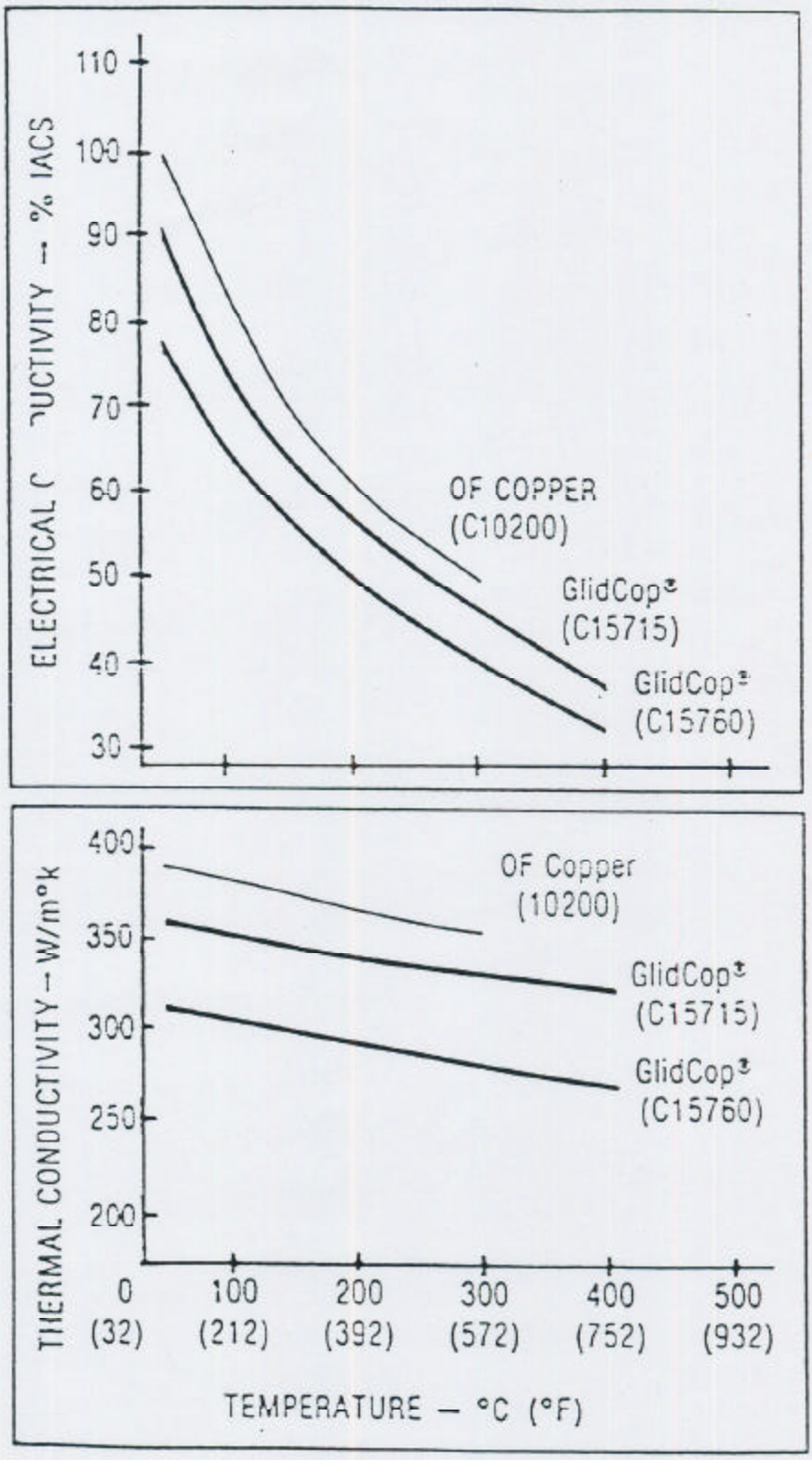




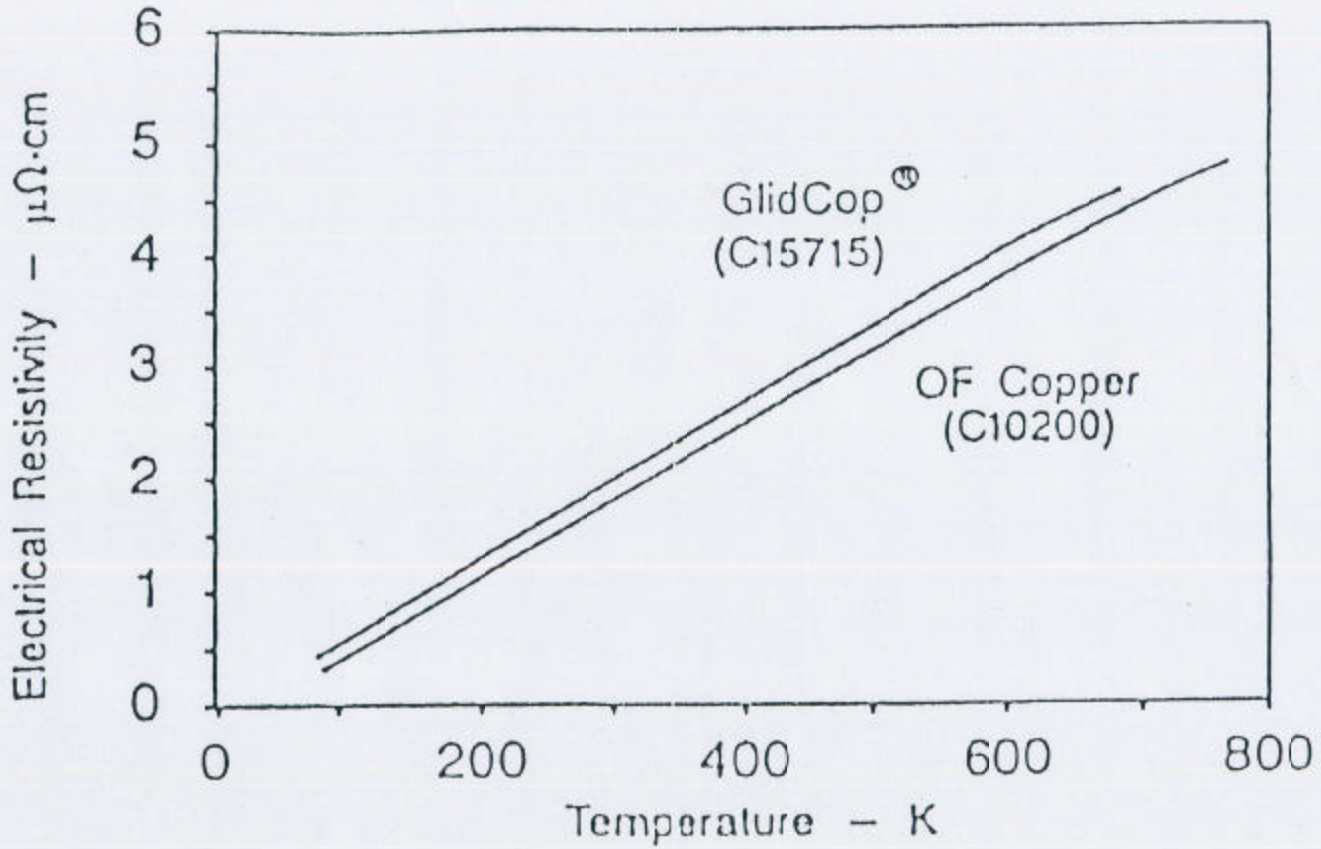


Thermal Conductivity of GlidCop
AL-15 vs OF Copper

SCM

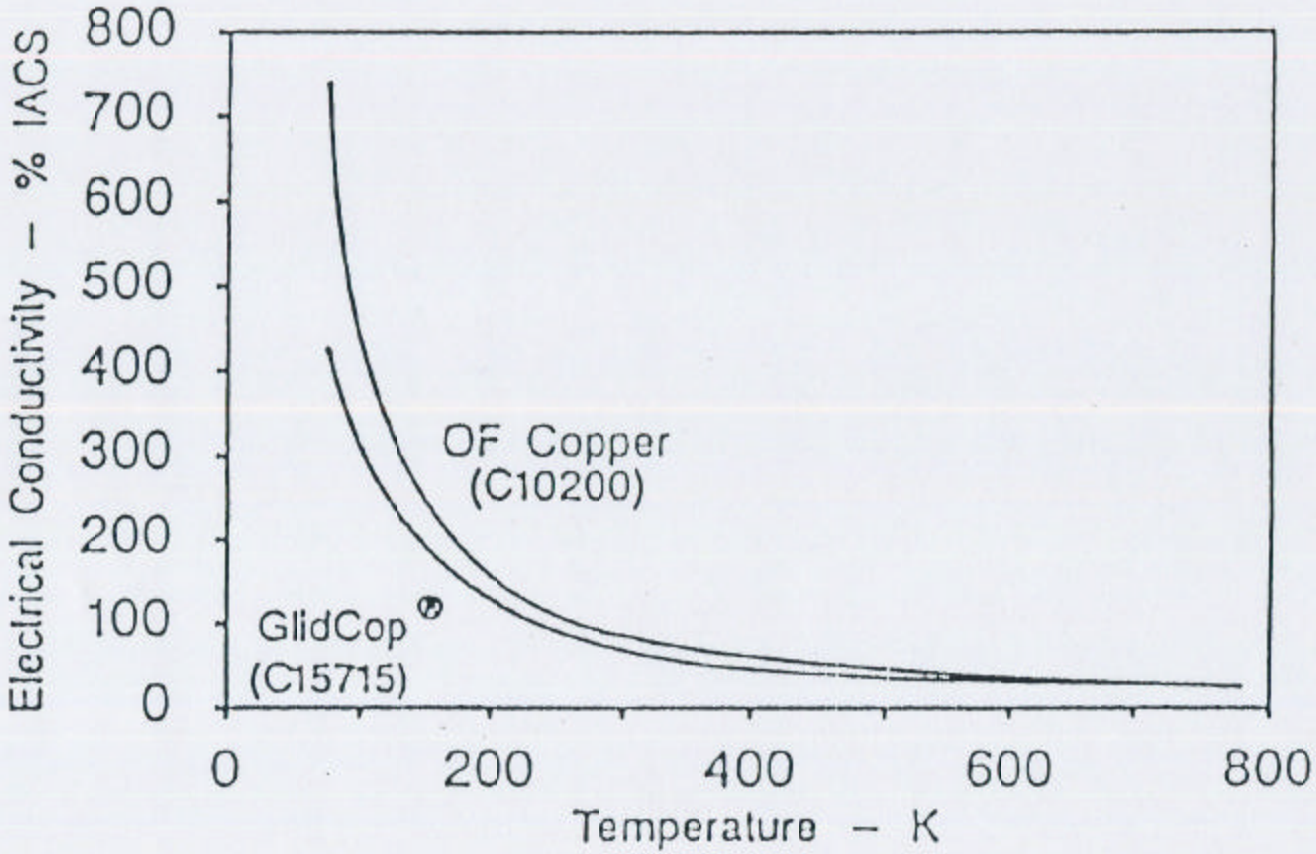


Elevated Temperature Electrical and Thermal Conductivities of GlidCop® vs. OF Copper



Electrical Resistivity of GlidCop
AL-15 vs OF Copper

SCM



Electrical Conductivity of GlidCop
AL-15 vs OF Copper

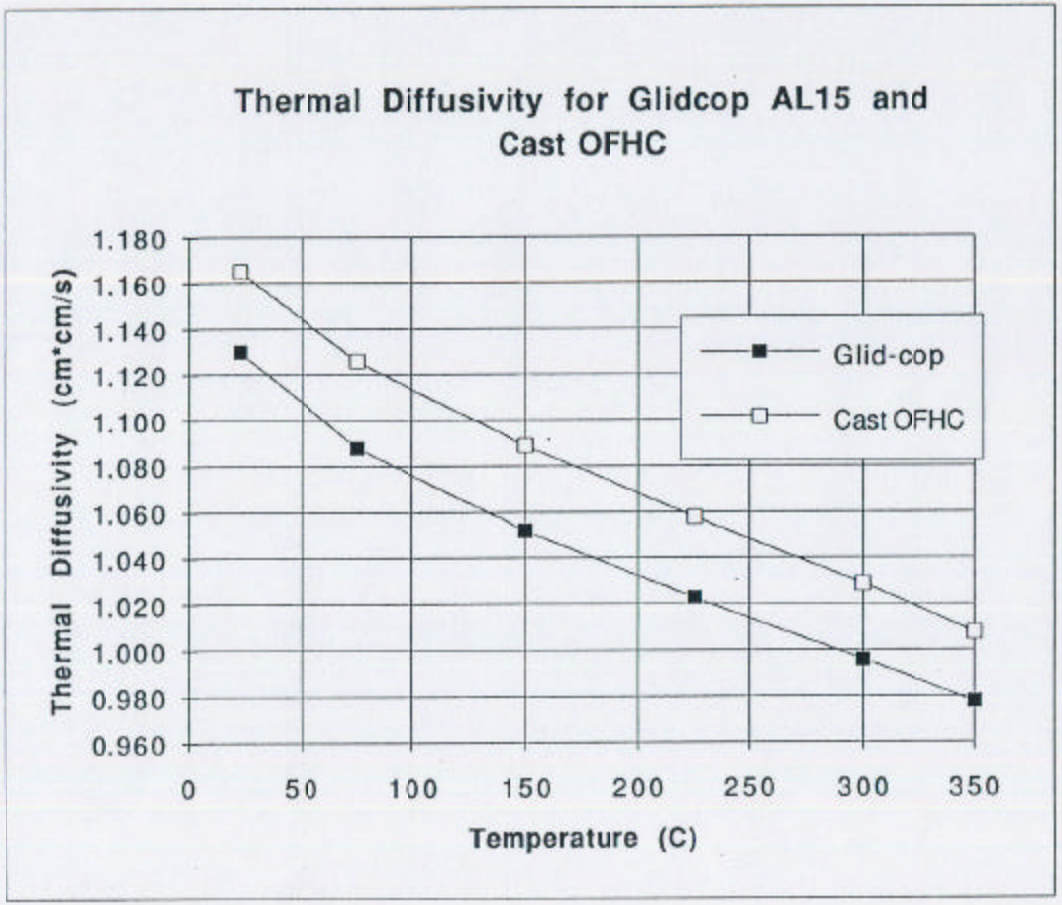
SCM

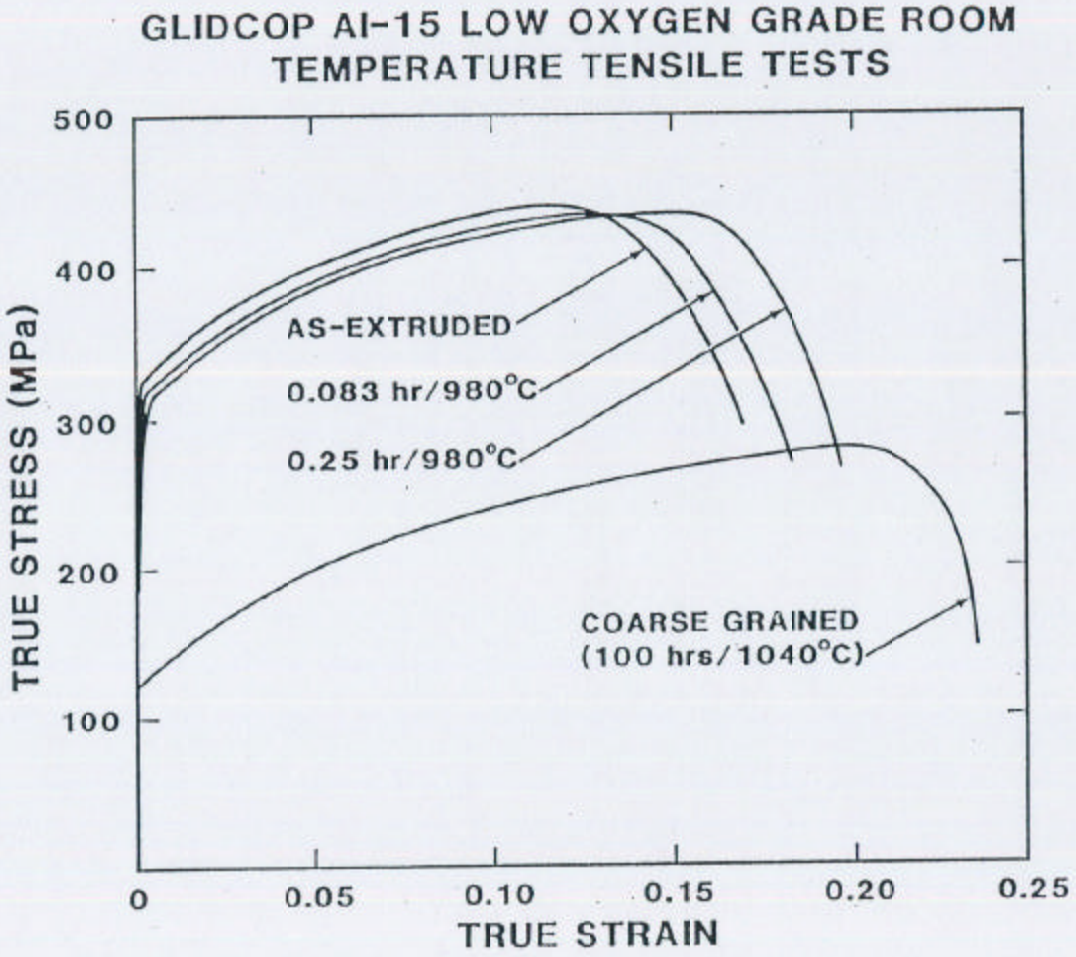
Glid-COP AL-15 and Cast OFHC Thermophysical Properties

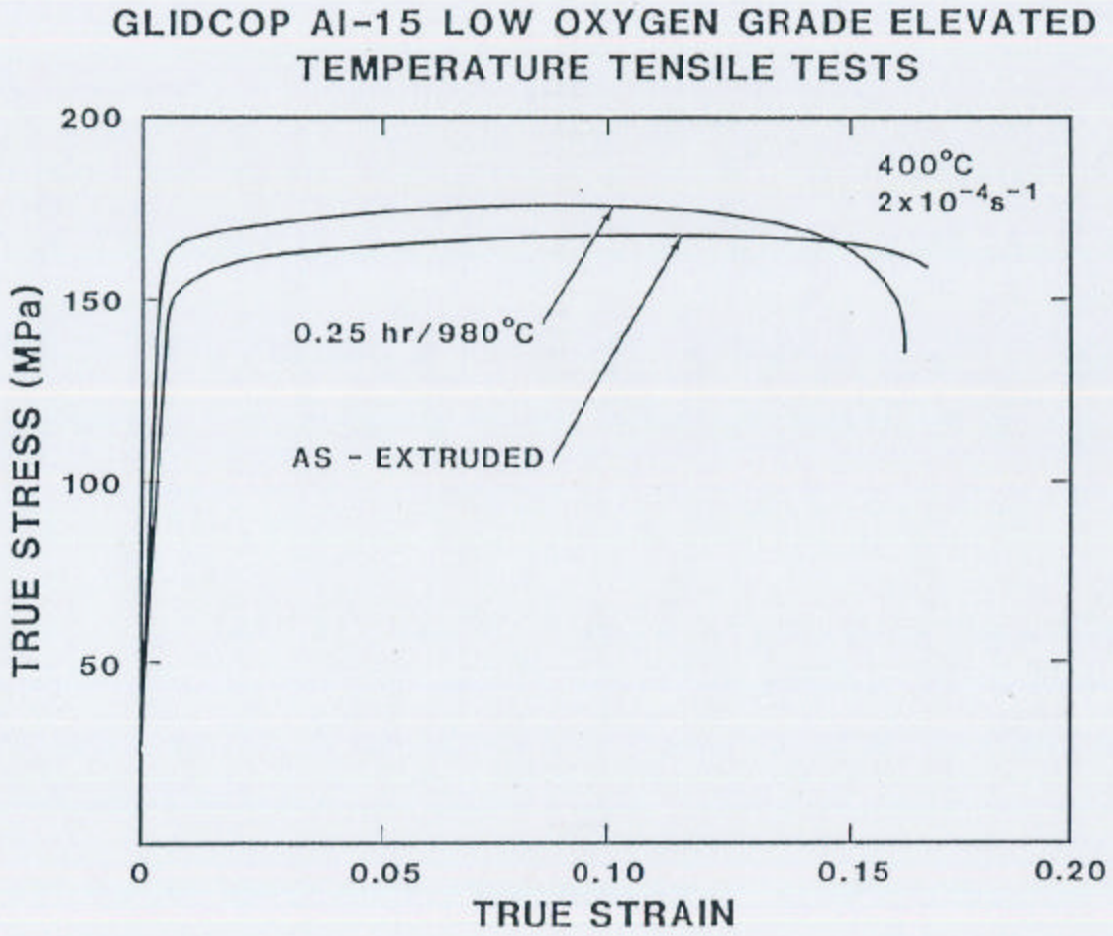
TPRL 1068, Jul. 1991

Thermal Diffusivity

Temperature (C)	Glid-cop	Cast OFHC
23	1.130	1.165
75	1.088	1.126
150	1.052	1.089
225	1.023	1.058
300	0.996	1.029
350	0.978	1.008




GLIDCOP AI-15 LOW OXYGEN GRADE ROOM TEMPERATURE TENSILE TESTS
TRUE STRESS (MPa)
500
400
300
200
100
AS-EXTRUDED
0.083 hr/980°C
0.25 hr/980°C
COARSE GRAINED
(100 hrs/1040°C)
0
0.05
0.10
0.15
0.20
0.25
TRUE STRAIN


GLIDCOP Al-15 LOW OXYGEN GRADE ELEVATED TEMPERATURE TENSILE TESTS
200
150
100
50
TRUE STRESS (MPa)
400°C
2x10⁻⁴s⁻¹
0.25 hr/980°C
AS - EXTRUDED
0
0.05
0.10
0.15
0.20
TRUE STRAIN

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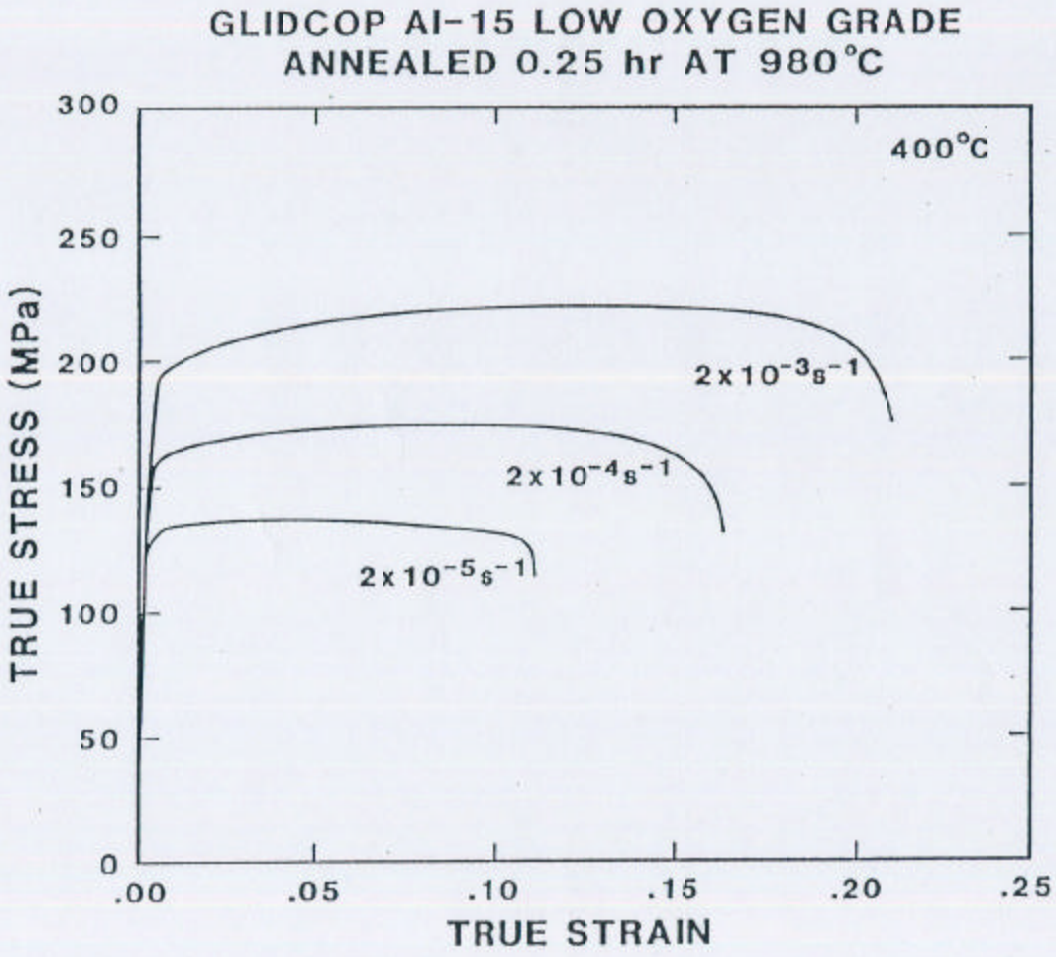
GLIDCOP Al-15 LOW OXYGEN GRADE
ANNEALED 0.25 hr AT 980°C
400°C
2x10⁻³s⁻¹
2x10⁻⁴s⁻¹
2x10⁻⁵s⁻¹
TRUE STRESS (MPa)
300
250
200
150
100
50
0
.00
.05
.10
.15
.20
.25
TRUE STRAIN

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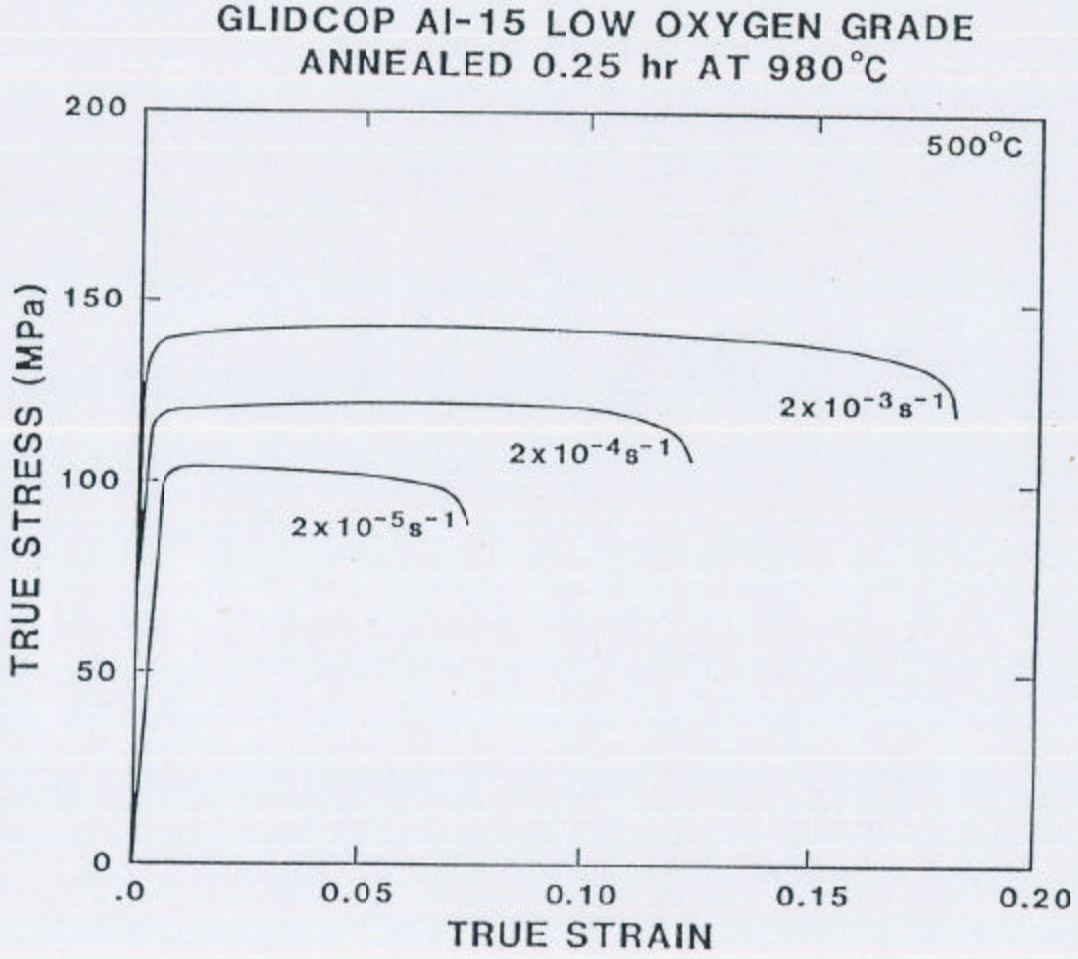
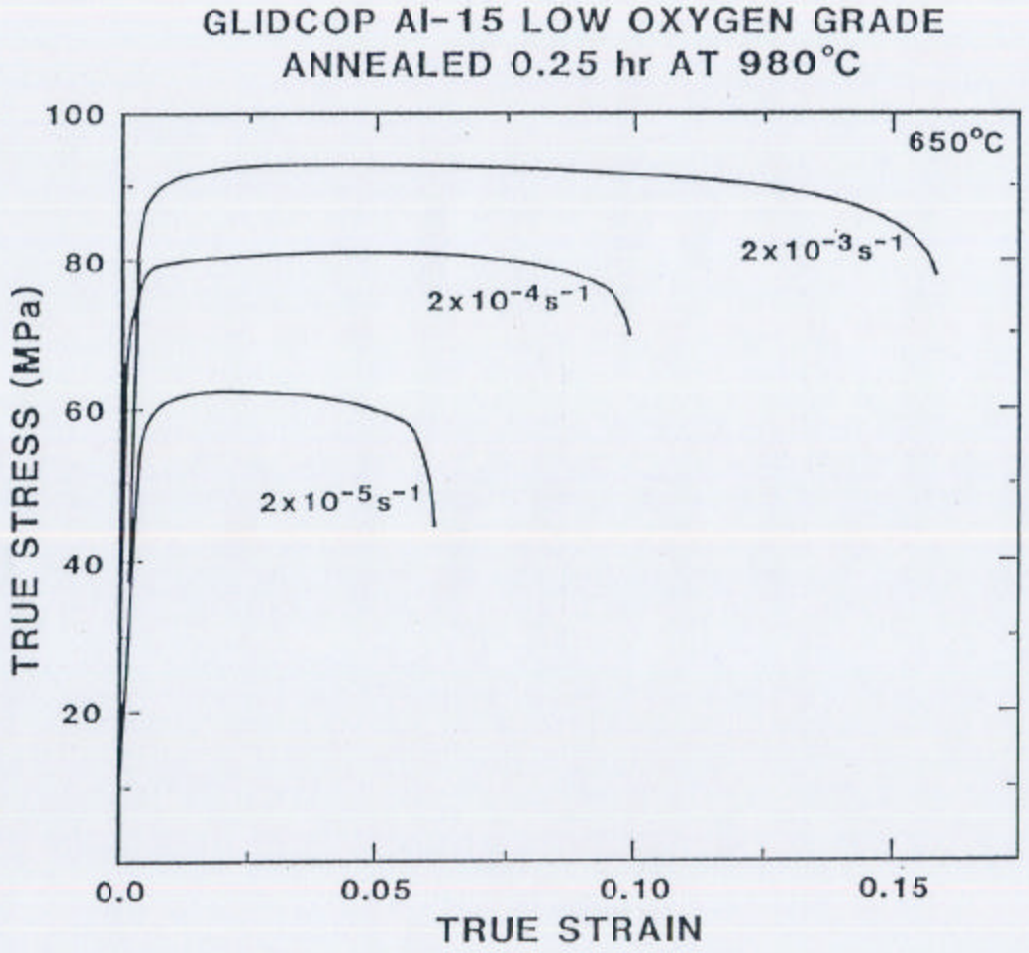
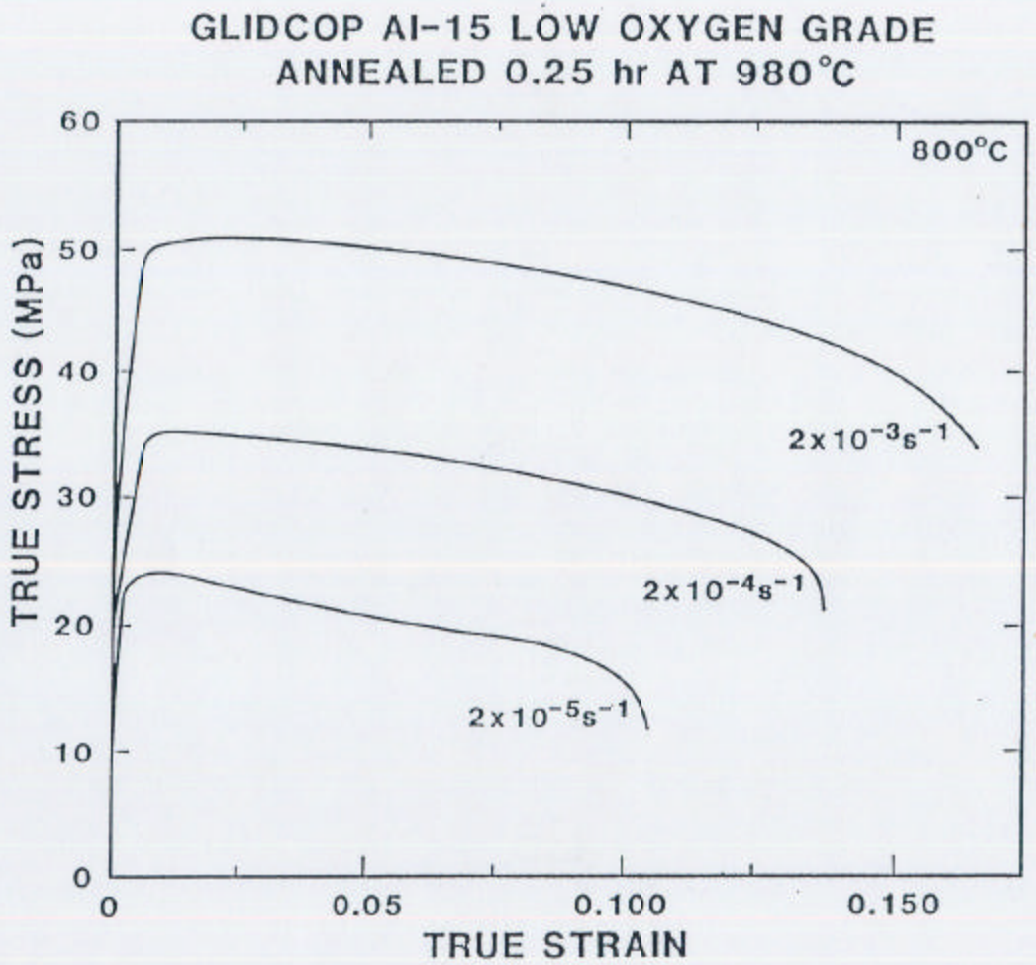
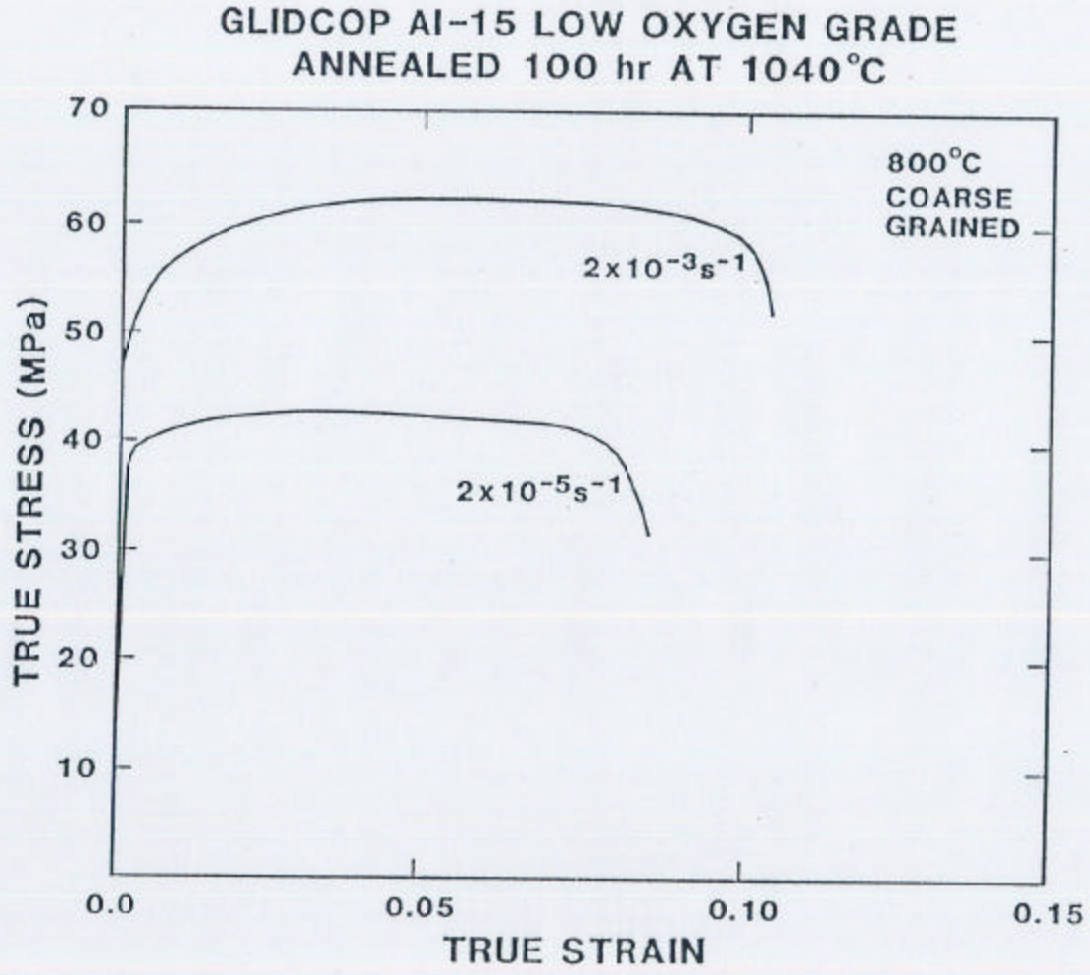

GLIDCOP Al-15 LOW OXYGEN GRADE
ANNEALED 0.25 hr AT 980°C
500°C
2x10⁻³s⁻¹
2x10⁻⁴s⁻¹
2x10⁻⁵s⁻¹
TRUE STRESS (MPa)
200
150
100
50
0
.0
0.05
0.10
0.15
0.20
TRUE STRAIN

Sandia

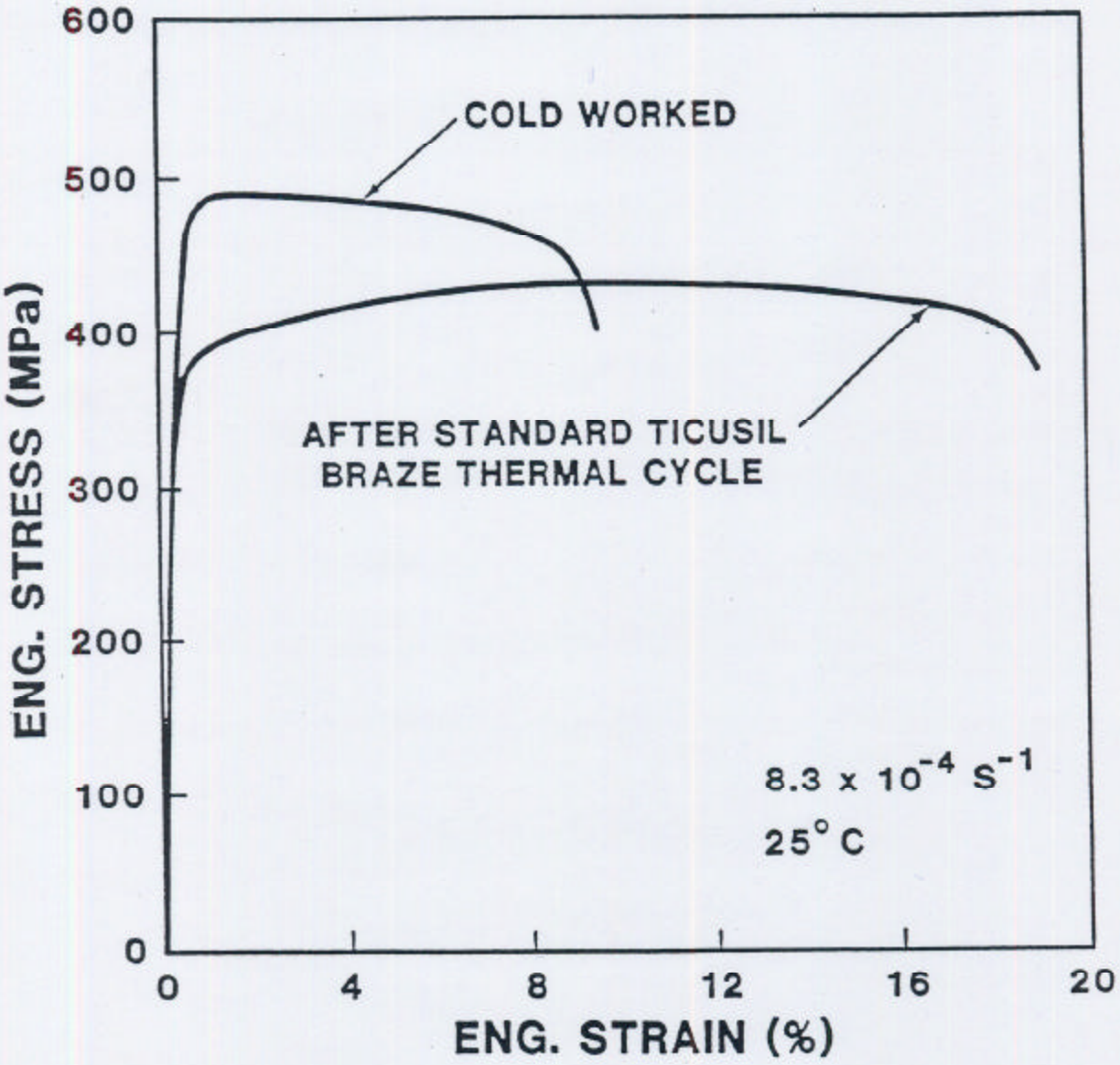

GLIDCOP Al-15 LOW OXYGEN GRADE
ANNEALED 0.25 hr AT 980°C
100
80
60
40
20
TRUE STRESS (MPa)
650°C
2x10⁻³s⁻¹
2x10⁻⁴s⁻¹
2x10⁻⁵s⁻¹
0.0
0.05
0.10
0.15
TRUE STRAIN


GLIDCOP AI-15 LOW OXYGEN GRADE
ANNEALED 0.25 hr AT 980°C
800°C
2x10⁻³s⁻¹
2x10⁻⁴s⁻¹
2x10⁻⁵s⁻¹
TRUE STRESS (MPa)
60
50
40
30
20
10
0
0
0.05
0.100
0.150
TRUE STRAIN

Sandia


GLIDCOP Al-15 LOW OXYGEN GRADE
ANNEALED 100 hr AT 1040°C
800°C
COARSE
GRAINED
2x10⁻³s⁻¹
2x10⁻⁵s⁻¹
TRUE STRESS (MPa)
70
60
50
40
30
20
10
0.0
0.05
0.10
0.15
TRUE STRAIN

EFFECT OF TICUSIL BRAZE THERMAL CYCLE ON TENSILE PROPERTIES OF GLIDCOP Al-15



Room temperature tensile properties of Al-15 tube specimens subjected to a standard (5 minute at 870°C) Ticusil braze cycle compared to cold worked Al-15. An engineering strain rate of 8.3×10^{-4} s^{-1} was used for both tests.

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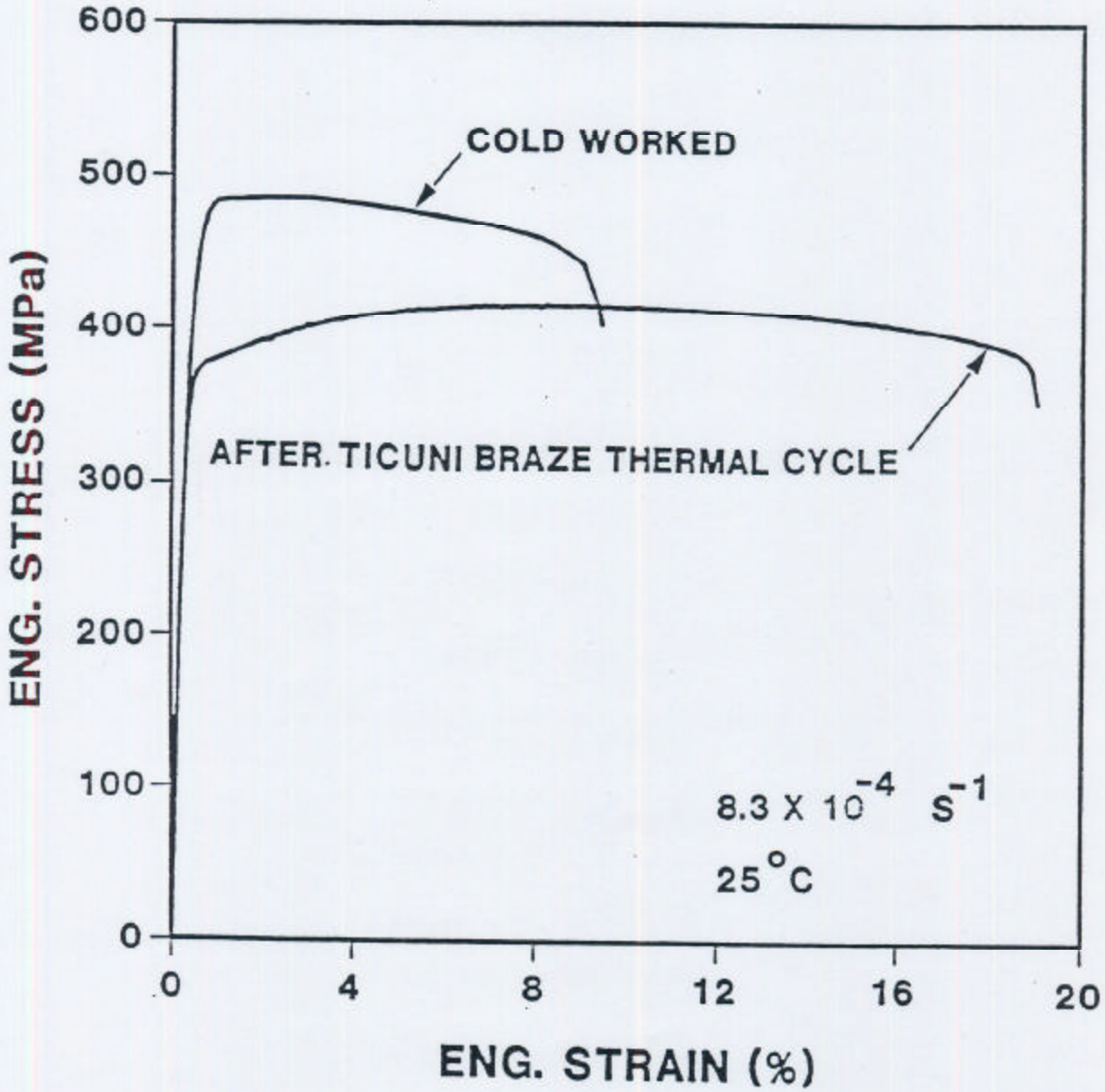
EFFECT OF TICUNI BRAZE THERMAL CYCLE ON TENSILE PROPERTIES OF GLIDCOP Al -15



Room temperature tensile properties of Al-15 tube specimens subjected to a standard (5 minute at 980°C) Ticuni braze cycle compared to cold worked Al-15. An engineering strain rate of 8.3×10^{-4} s^{-1} was used for both tests.

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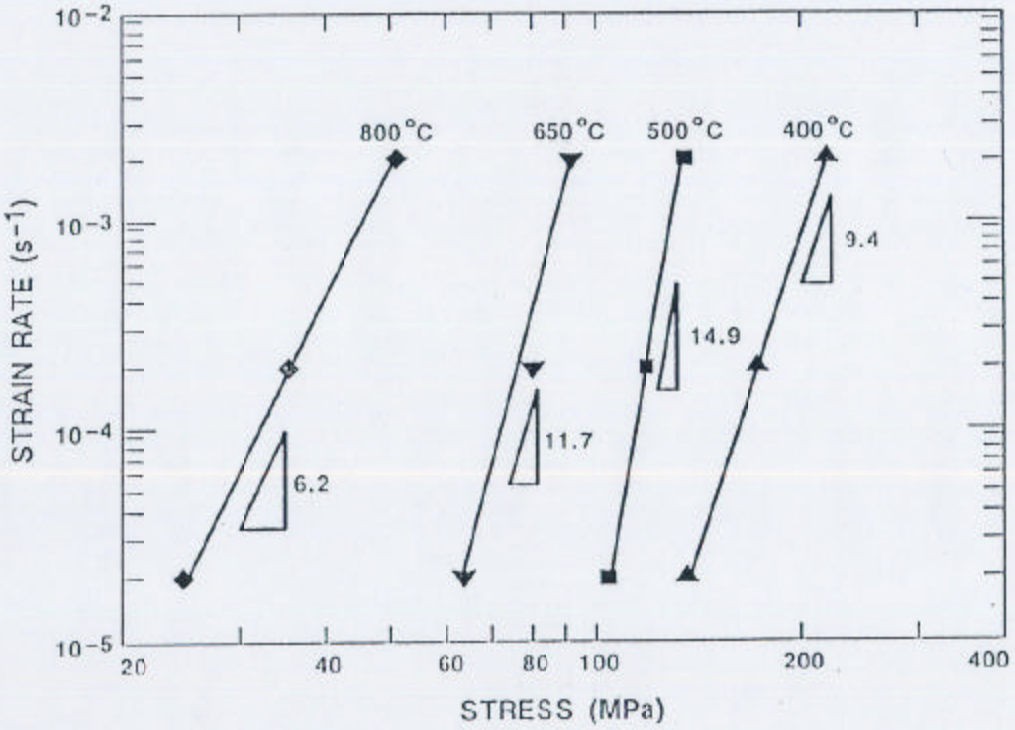
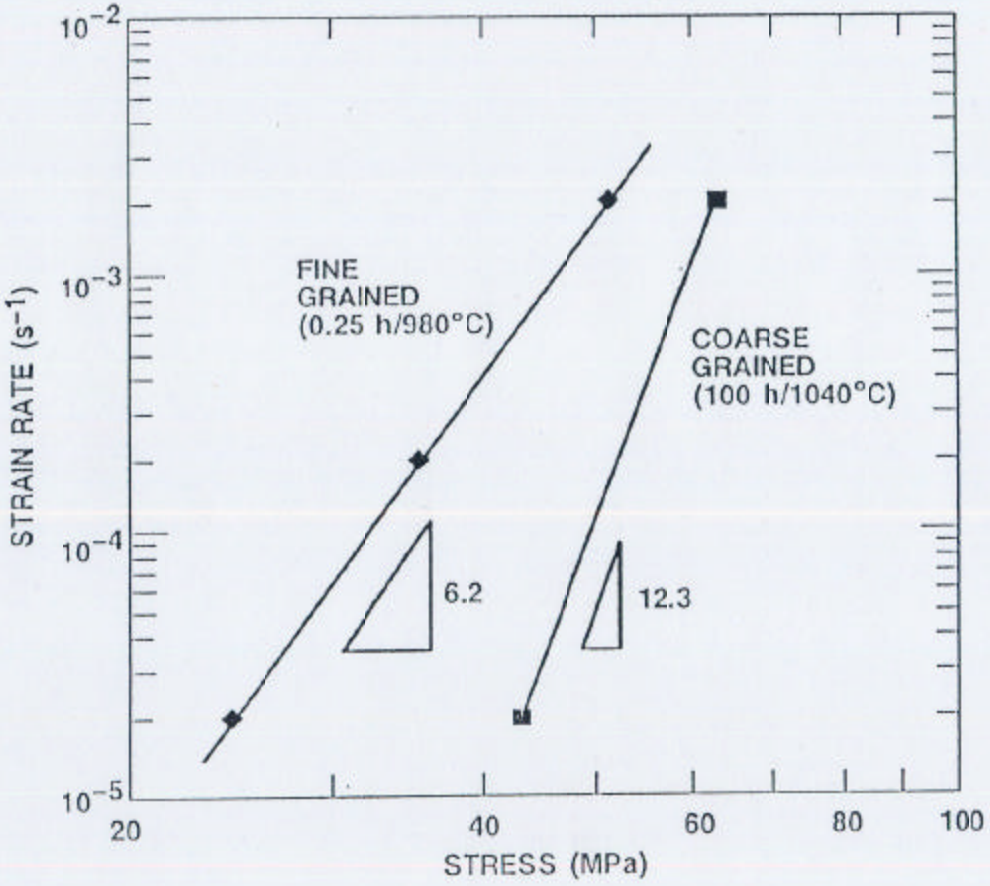
GLIDCOP Al–15 LOW OXYGEN GRADE
DISPERSION STRENGTHENED COPPER – FINE GRAINED
MATERIAL ANNEALED 0.25 h AT 980°C



GLIDCOP Al–15 LOW OXYGEN GRADE DISPERSION STRENGTHENED COPPER FLOW STRESS – STRAIN RATE DATA – 800°C



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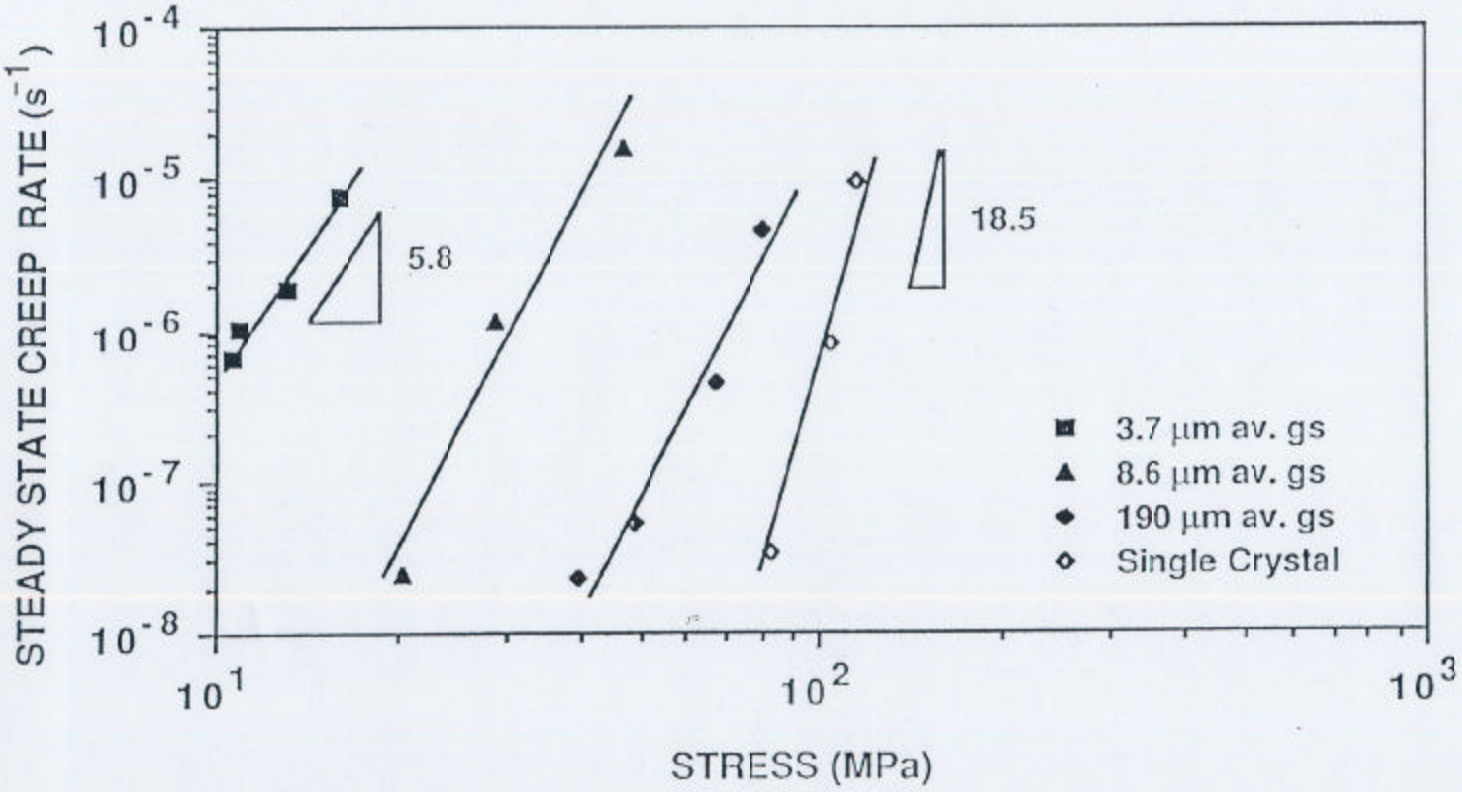
0935

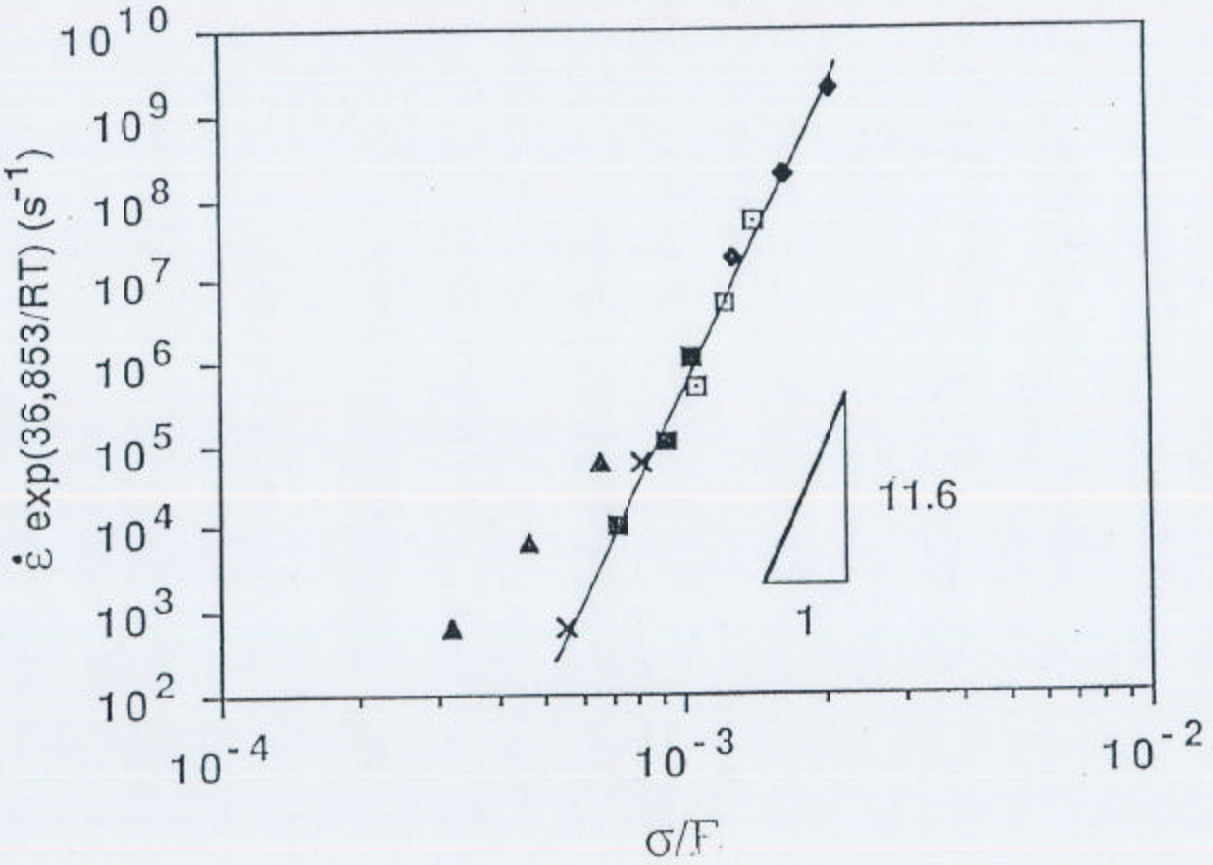
1093°C CREEP OF TDNiCr: DATA OF KANE & EBERT (1976)



GLIDCOP Al-15 LOW OXYGEN GRADE

OXIDE DISPERSION STRENGTHENED COPPER

TEMPERATURE-COMPENSATED FLOW STRESS VS. STRAIN RATE



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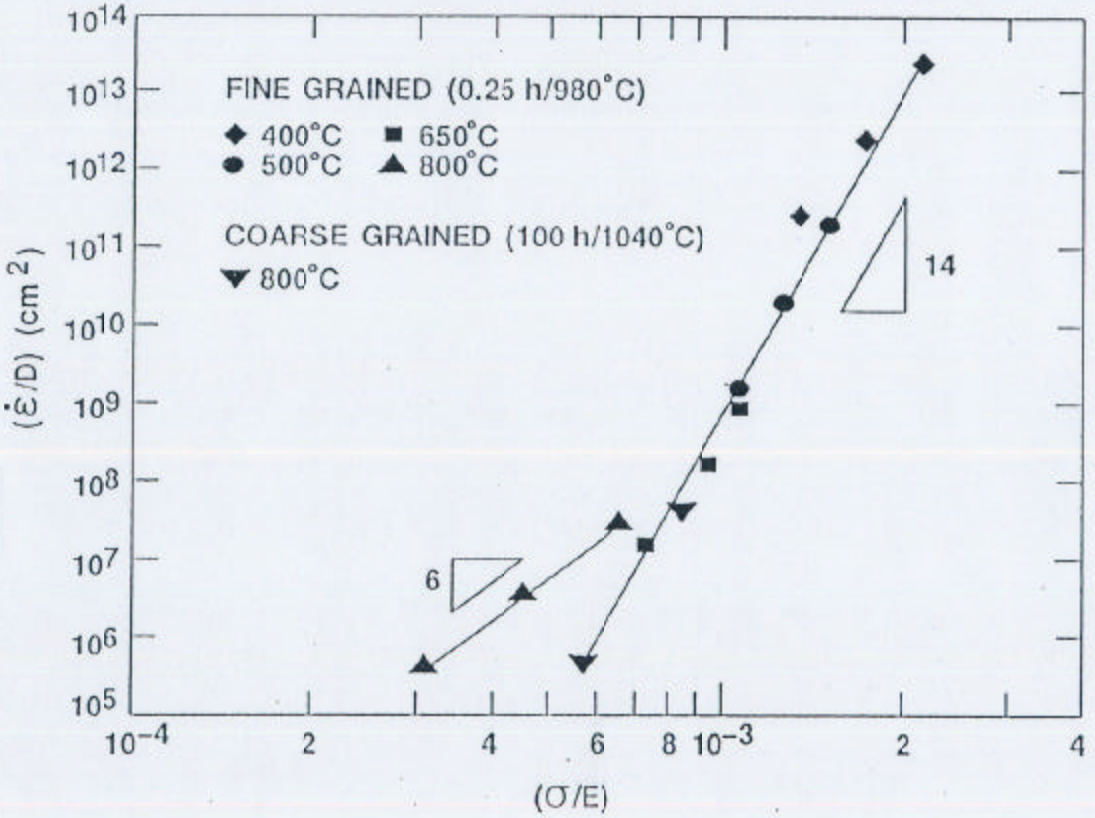
GLIDCOP Al-15 LOW OXYGEN GRADE
OXIDE DISPERSION STRENGTHENED COPPER
TEMPERATURE-COMPENSATED DATA: FLOW STRESS VS. STRAIN RATE



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References

1. Douglas F. Miner and John B. Seastone, Handbook of Engineering Material, John Welly & Sons, Inc. 1st Ed.
2. R. E. Taylor, H. Groot and J. Larimore, Thermophysical Properties of Various Copper Alloys, A Report to Argonne National Laboratory, TPRL 1068, July 1991.
3. Robert J. Plecki, Room and Elevated Temperature Tensile Testing of Bar Specimens Purchase Order No. 060654, Memo to J. Howell, Feb. 1991.
4. J. D. Troxell, GlidCop Dispersion Strengthened Copper: Potential Applications in Fusion Power Generators, SCM Metal Products, Inc.
5. J. J. Stephens, R. J. Bourcier, F. J. Vigil and D. T. Schmale, Mechanical Properties of Dispersion Strengthened Copper: A Comparison of Braze Cycle Annealed and Coarse Grain Microstructures, SANDIA Report SAND88-1351, UC-25, Sep. 1988.
6. J. J. Stephens and D. T. Schnale, The Effect of High Temperature Braze Thermal Cycles on Mechanical Properties of a Dipersion Strengthened Copper Alloy, SANDIA Report, SAND87-1296, UC-20, Dec. 1988.
7. Prasan K. Samal, Brazing and Diffusion Bonding of Glidcop Dipersion Strengthened Copper, SCM Metal Products, Inc.
8. SCM Metal Products, Inc. Technical Data, Glidcop Grade AL-15 Dispersion Strengthened Copper.