

Al
4.5 Cu
1.5 Mg
0.6 Mn

2024

Alloy	2024
Condition	Thermal Conductivity, Btu ft/(hr ft ² F)
0	111.7
T3, T36, T351, T361, T4	70.0
T6, T81, T851, T861	88.5

TABLE 2.0131. THERMAL CONDUCTIVITY AT ROOM TEMPERATURE FOR VARIOUS HEAT-TREATED CONDITIONS (16) (19)

Alloy	2024		
Condition	Resistivity, Microhm inch	Conductivity, Megohms/in. ³	Conductivity, percent IACS
0	1.37	0.730	49.6
T3, T36, T351, T361, T4	2.29	0.437	29.7
T6, T81, T851, T861	1.77	0.565	38.4

TABLE 2.022. ELECTRICAL PROPERTIES (16) (19)

Alloy	2024			
Form	2.5-inch Thick Plate			
Condition	Orientation	Stress, ksi	Time to SC Failure, days ^(a)	Loss in F _{TU} , percent ^(a)
T851	L	0	---	15
T851	L	45	---	14
T851	ST	0	---	42
T851	ST	46	---	35
T851	ST	27	---	42
T351	L	0	---	15
T351	L	45	---	20
T351	T	0	---	37
T351	T	46	25	---
T351	T	27	67	---

(a) Tensile specimens, 0.125-in. diam. x 2 in. long, exposed to alternate immersion in 3.5 percent aqueous sodium chloride solution, 10 minutes in solution and 50 minutes in air each hour, at given stresses until stress corrosion failure or for 84 days. Specimens that did not fail within 84 days were then tensile tested to determine loss of strength.

TABLE 2.0311. EFFECTS OF HEAT-TREAT CONDITION, ORIENTATION, AND STRESS ON TIME TO STRESS-CORROSION FAILURE OR ON LOSS OF TENSILE STRENGTH DUE TO ALTERNATE IMMERSION IN 3.5 PERCENT SODIUM CHLORIDE SOLUTION (14)

Alloy	2024				
Condition	Orientation	Plate ^(a)	Rolled Rod & Bar ^(a)	Extruded Shapes	
				0.25-1 inch ^(a)	1.25-2 inch ^(a)
T3, T4	L	35	30	>50	>50
T3, T4	T	20	---	37	18
T3, T4	ST	7	10	---	7
T6, T8	L	>50	>47	>60	>60
T6, T8	T	>50	---	50	50
T6, T8	ST	43	>43	---	16

(a) Numbers indicate highest sustained tensile stress (ksi) at which test specimens did not fail in 84-day test duration in aqueous 3.5 percent sodium chloride alternate-immersion test (10 minutes in solution and 50 minutes in air).

TABLE 2.0312. RESISTANCE TO STRESS CORROSION OF VARIOUS PRODUCT FORMS, HEAT TREAT-CONDITIONS, AND ORIENTATIONS (29)

2024-T4				
0.063-inch Thick Sheet				
Alloy	Form	Exposure. days	Percent Failed in SC	Average Loss of F_{ty} , percent
				Unstressed(a) Stressed(a)
3.5% NaCl(b)		84	0	33 40
Seacoast		365	0	16 20
Industrial		365	0	6 9

Al
 4.5 Cu
 1.5 Mg
 0.6 Mn
 2024

- (a) Half of the specimens unstressed and other half stressed at 75 percent of F_{ty} .
- (b) Alternate immersion: 10 minutes in aqueous NaCl solution and 50 minutes in air.

TABLE 2.0313. SUMMARY OF THE EFFECTS OF EXPOSURES TO VARIOUS ENVIRONMENTS ON STRESS-CORROSION BEHAVIOR AND LOSS OF TENSILE STRENGTH OF NUMEROUS SHEET SPECIMENS (BOTH LONGITUDINAL AND TRANSVERSE) (28)

2024-T852				
3 x 18 x 35-inch Forged Block				
Orientation	Environment	K_{Ic} , ksi/in.	K_{Isc} , ksi/in.	K_{Isc}/K_{Ic}
LT(a)	FTSRW(d)	28.0	22.5	0.80
LS(b)	FTSRW(d)	—	20.0	—
TL(c)	FTSRW(d)	27.0	20.5	0.76
LT(a)	SCS(e)	37.0	28.0	0.76

- (a) Longitudinal loading – transverse fracture direction.
- (b) Longitudinal loading – short-transverse fracture direction.
- (c) Transverse loading – longitudinal fracture direction.
- (d) Artificial fuel tank sump residue water (B-1 bomber).
- (e) Metal cleaning solvent.

TABLE 2.0314. COMPARISON OF K_{Ic} AND K_{Isc} OF FORGINGS (25)

2024						
Alloy	Condition	Form	Thickness, inches	F_{ty} , ksi (Min)	F_{tu} , ksi (Min)	Elongation, e. (2 inch or 4D), percent. (Min)
0		Sheet & Plate	0.010-0.499	14.0 (Max)	32.0 (Max)	12
			0.500-1.750	—	32.0 (Max)	12
T3		Flat Sheet	0.008-0.009	42.0	63.0	10
			0.010-0.020	42.0	63.0	12
			0.021-0.128	42.0	63.0	15
			0.129-0.249	42.0	64.0	15
T361		Flat Sheet & Plate	0.020-0.062	50.0	67.0	8
			0.063-0.249	51.0	68.0	9
			0.250-0.499	49.0	66.0	9
			0.500	49.0	66.0	10
T4		Coiled Sheet	0.010-0.020	40.0	62.0	12
			0.021-0.249	40.0	62.0	15
T351		Plate	0.250-0.499	42.0	64.0	12
			0.500-1.000	42.0	63.0	8
			1.001-1.500	42.0	62.0	7
			1.501-2.000	42.0	62.0	6
			2.001-3.000	42.0	60.0	4
			3.001-4.000	41.0	57.0	4
			0.010-0.020	38.0	62.0	12
T42		Sheet & Plate	0.021-0.249	38.0	62.0	15
			0.250-0.499	38.0	62.0	12
			0.500-1.000	38.0	61.0	8
			1.001-1.500	38.0	60.0	7
			1.501-2.000	38.0	60.0	6
			2.001-3.000	38.0	58.0	4
			0.010-0.499	50.0	64.0	5
T62		Sheet & Plate	0.500-3.000	50.0	63.0	5
			0.010-0.249	46.0	60.0	5
T72		Sheet	0.010-0.249	58.0	67.0	5
T81		Flat Sheet	0.010-0.249	58.0	67.0	5
T851		Plate	0.250-0.499	58.0	67.0	5
			0.500-1.000	58.0	66.0	5
			1.001-1.499	57.0	66.0	5
T861		Flat Sheet & Plate	0.020-0.062	62.0	70.0	3
			0.063-0.249	66.0	71.0	4
			0.250-0.499	64.0	70.0	4
			0.500	64.0	70.0	4

TABLE 3.011. ALUMINUM ASSOCIATION MECHANICAL-PROPERTY LIMITS FOR SHEET AND PLATE (16)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

Alloy		2024			
Form		Drawn Table			
Condition	Wall Thickness, inch	F _{ty} , ksi (Min)	F _{tu} , ksi (Min)	e. (2 inch or 4D), (Min)	
				Full Section	Cut-out Spec
0	0.018-0.500	15.0 (Max)	32.0 (Max)	---	---
T3	0.018-0.024	42.0	64.0	10	---
	0.025-0.049	42.0	64.0	12	10
	0.050-0.259	42.0	64.0	14	10
	0.260-0.500	42.0	64.0	16	12
T42	0.018-0.024	40.0	64.0	10	---
	0.025-0.049	40.0	64.0	12	10
	0.050-0.259	40.0	64.0	14	10
	0.260-0.500	40.0	64.0	16	12

TABLE 3.012. ALUMINUM ASSOCIATION MECHANICAL-PROPERTY LIMITS FOR DRAWN TUBE (16)

Alloy		2024			
Form		Drawn Table			
Condition	Wall Thickness, inches	Area, in. ²	F _{ty} , ksi (Min)	F _{tu} , ksi (Min)	Elongation,
					e. (2 inch or 4D), percent, (Min)
0	All	All	19.0 (Max)	35.0 (Max)	12
T3, T3510, & T3511	Up Thru 0.249	All	42.0	57.0	10
	0.250-0.749	All	44.0	60.0	10
	0.750-1.499	All	46.0	65.0	10
	1.500 and Over	Up Thru 25	48.0	70.0	10
T42	1.500 and Over	25-32	46.0	68.0	8
	Up Thru 0.749	All	38.0	57.0	12
	0.750-1.499	All	38.0	57.0	10
	1.500 and Over	Up Thru 25	38.0	57.0	10
T81, T8510 & T8511	1.500 and Over	25-32	38.0	57.0	8
	0.050-0.249	All	56.0	64.0	4
	0.250-1.499	All	58.0	66.0	5
	1.500 and Over	Up Thru 32	58.0	66.0	5

TABLE 3.013. ALUMINUM ASSOCIATION MECHANICAL-PROPERTY LIMITS FOR EXTRUDED TUBE (16)

Alloy		2024			
Form		Extruded Wire, Rod, Bar, and Shapes			
Condition	Diameter or Thickness, inches	Area, in. ²	F _{ty} , ksi (Min)	F _{tu} , ksi (Min)	Elongation,
					e. (2 inch or 4D), percent, (Min)
0	All	All	19.0 (Max)	35.0 (Max)	12
T3, T3510, & T3511	Up Thru 0.249	All	42.0	57.0	12
	0.250-0.749	All	44.0	60.0	12
	0.750-1.499	All	46.0	65.0	10
	1.500 and Over	Up Thru 25	52.0	70.0	10
T42	1.500 and Over	25-32	48.0	68.0	8
	Up Thru 0.749	All	38.0	57.0	12
	0.750-1.499	All	38.0	57.0	10
	1.500 and Over	Up Thru 25	38.0	57.0	10
T81, T8510, & T8511	1.500 and Over	25-32	38.0	57.0	8
	0.050-0.249	All	56.0	64.0	4
	0.250-1.499	All	58.0	66.0	5
	1.500 and Over	Up Thru 32	58.0	66.0	5

TABLE 3.014. ALUMINUM ASSOCIATION MECHANICAL-PROPERTY LIMITS FOR EXTRUDED WIRE, ROD, BAR, AND SHAPES (16)

Alloy	2024			
Form	Rolled Wire, Rod, and Bar			
Condition	Diameter or Thickness, inches	F _{ty} , ksi (Min)	F _{tu} , ksi (Min)	Elongation, e. (2 inch or 4D), percent (Min)
0	Up Thru 8.000	--	35.0 (Max)	16
T36	Up Thru 0.375	52.0	69.0	10
T4	Up Thru 0.499	45.0	62.0	10
	0.500-4.500	42.0	62.0	10
	4.501-6.500	40.0	62.0	10
	6.501-8.000	38.0	58.0	10
T42	Up Thru 6.500	40.0	62.0	10
T351	0.500-6.500	45.0	62.0	10
T6	Up Thru 6.500	50.0	62.0	5
T62	Up Thru 6.500	46.0	60.0	5
T851	0.500-6.500	58.0	66.0	5

TABLE 3.015. ALUMINUM ASSOCIATION MECHANICAL-PROPERTY LIMITS FOR ROLLED WIRE, ROD, AND BAR (16)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

Alloy	2024-T4
Form	Cold-Heading Wire and Rod, 0.063-1.000 inch Diameter
F _{ty} , ksi (Min)	40.0
F _{tu} , ksi (Min)	62.0
Elongation, e. (2 inch or 4D), percent (Min)	10
F _{su} , ksi	37.0

TABLE 3.016. ALUMINUM ASSOCIATION MECHANICAL-PROPERTY LIMITS FOR COLD-HEADING WIRE AND ROD (16)

Alloy	2024			
Condition	F _{ty} , ksi	F _{tu} , ksi	Elongation, e. (2 inch), percent	
			1/16 inch thick	1/2 inch diameter
0	11	27	20	22
T3	50	70	18	--
T4, T351	47	68	20	19
T361, T36	57	72	13	--
T6	57	69	10	--
T81, T851	65	70	6	--
T86	71	75	6	--

TABLE 3.0214. TYPICAL TENSILE PROPERTIES FOR VARIOUS HEAT-TREATED CONDITIONS (16) (26)

Alloy	2024								
Form	2.5-inch Thick Plate								
Orientation	Longitudinal			Transverse			Short Transverse		
	F _{ty} , ksi	F _{tu} , ksi	Elongation, e. (4D), percent	F _{ty} , ksi	F _{tu} , ksi	Elongation, e. (4D), percent	F _{ty} , ksi	F _{tu} , ksi	Elongation, e. (4D), percent
T351	53.9	70.7	12.0	47.4	68.2	17.4	43.0	57.2	3.5
T851	60.0	67.2	8.0	63.3	69.5	7.2	62.0	64.5	1.0

TABLE 3.0215. TENSILE PROPERTIES OF PLATE IN DIFFERENT ORIENTATIONS AND HEAT-TREAT CONDITIONS (14)

Alloy	2024-T852								
Form	Hand Forgings								
Orientation	Longitudinal			Transverse			Short Transverse		
	F _{ty} , ksi	F _{tu} , ksi	Elongation, e. (2 inch), percent	F _{ty} , ksi	F _{tu} , ksi	Elongation, e. (2 inch), percent	F _{ty} , ksi	F _{tu} , ksi	Elongation, e. (2 inch), percent
2 x 8	67.2	72.4	5.0	71.2	76.4	7.0	--	--	--
4 x 8	61.7	67.8	7.5	64.2	70.8	5.5	--	--	--
5 x 5	63.9	70.2	9.0	61.1	66.5	3.5	58.1	67.0	3.5
5 x 20	56.9	65.5	8.0	56.9	63.3	3.0	55.3	61.9	3.0
6 x 12	58.5	66.5	9.0	59.9	66.8	2.0	54.5	64.2	2.5

TABLE 3.0216. TENSILE PROPERTIES OF HAND FORGINGS IN DIFFERENT SIZES AND ORIENTATIONS (9)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

Alloy		2024-T852		
Form		Hand Forgings		
Property		Compressive Yield Strength, F_{cy} , ksi		
Forging Section, inches		Longitudinal	Transverse	Short Transverse
2 x 8		70.1	64.1	-
4 x 8		62.5	60.6	-
5 x 5		64.8	62.2	67.7
5 x 20		56.0	60.6	60.7
6 x 12		59.1	63.2	63.3

TABLE 3.0222. COMPRESSIVE YIELD STRENGTH OF HAND FORGINGS IN DIFFERENT SIZES AND ORIENTATIONS (9)

Alloy		2024	
Condition		Shear Strength, F_{su} , ksi	
0		18	
T3, T4, T351, T6		41	
T36, T361		42	
T81, T851		43	
T86		45	

TABLE 3.0251. TYPICAL SHEAR STRENGTH FOR VARIOUS HEAT-TREATED CONDITIONS (16) (26)

Alloy		2024-T852		
Form		Hand Forgings		
Property		Shear Strength, F_{su} , ksi		
Forging Section, inches		Longitudinal	Transverse	Short Transverse
2 x 8		42.7	41.8	-
4 x 8		40.5	39.5	38.6
5 x 5		40.8	40.7	39.6
5 x 20		38.8	38.0	37.0
6 x 12		39.6	38.4	37.4

TABLE 3.0252. SHEAR STRENGTH OF HAND FORGINGS IN VARIOUS SIZES AND ORIENTATIONS (9)

Alloy		2024-T852			
Form		Hand Forgings			
Property		Bearing Yield Strength, F_{brv} , ksi		Bearing Ultimate Strength, F_{bru} , ksi	
Forging Section, inches	Specimen Orientation				
		e/d=1.5	e/d=2.0	e/d=1.5	e/d=2.0
2 x 8	L	95.5	116.3	97.7	133.1
	T	89.5	114.2	94.5	125.9
4 x 8	L	82.5	100.5	91.9	117.9
	T	82.8	101.0	88.8	119.4
5 x 5	L	89.9	105.1	93.5	125.2
	T	84.4	101.1	89.1	121.6
5 x 20	L	79.3	94.4	83.6	112.6
	T	82.5	98.0	84.9	114.6
6 x 12	L	82.4	100.5	84.7	117.1
	T	81.4	95.7	85.7	113.4

TABLE 3.0261. BEARING PROPERTIES OF HAND FORGINGS IN VARIOUS SIZES AND ORIENTATIONS (9)

Alloy		2024-T851				
Form		Plate				
Plate Thickness, inches	Notched Specimen Diameter, inches	Specimen Orientation	Notch Tensile Strength, (NTS), ksi	F_{Tu} , ksi	F_{Ty} , ksi	
						1-3/8
1-3/8	1-1/16	T	51.0	71.2	64.8	
6.0	1/2	ST	40.5	67.7	59.9	
6.0	1-1/16	ST	29.0	67.7	59.9	

TABLE 3.02712. EFFECTS OF SPECIMEN SIZE AND ORIENTATION ON SHARP-NOTCH TENSILE STRENGTH (34)

Alloy 2024-T851		
Form Plate		
Plate Thickness, inches	Specimen Orientation	K _{Ic} , ksi√in.
1.00	L-T	20.9
	T-L	18.7
	L-T	22.8
1.37	T-L	19.6

TABLE 3.02721. FRACTURE TOUGHNESS FOR VARIOUS PLATE THICKNESSES AND ORIENTATIONS (35)

Alloy 2024		
Form 2.5-inch Thick Plate		
Orientation	Longitudinal (L-T)	Short Transverse (S-L)
Condition	K _{Ic} , ksi√in.	K _{Ic} , ksi√in.
T351	29.6	21.0
T851	25.3	16.7

TABLE 3.02723. FRACTURE TOUGHNESS OF PLATE IN VARIOUS LOADING ORIENTATIONS AND HEAT-TREATED CONDITIONS (14)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

Alloy 2024-T852			
Form Hand Forgings			
Property K _{Ic} , ksi√in.			
Forging Section, inches	Orientation		
	Longitudinal	Transverse	Short Transverse
2 x 8	24.2	21.5	-
3 x 12	23.0	17.7	-
4 x 16	27.3	-	15.6
5 x 20	27.1	17.6	15.9
6 x 24	29.9	16.6	16.2

TABLE 3.02724. FRACTURE TOUGHNESS OF HAND FORGINGS IN VARIOUS SIZES AND ORIENTATIONS (9)

Alloy 2024	
Condition	Fatigue Limit for 5 x 10 ⁸ cycles, ksi ^(a)
0	13
T36, T6, T81, T851, T86	18
T3, T4, T351	20

(a) Rotating beam, R = -1, smooth specimens.

TABLE 3.052. TYPICAL FATIGUE LIMITS FOR VARIOUS HEAT-TREATED CONDITIONS (16) (26)

Alloy 2024-T852		
Form Hand Forgings		
Property Modulus of Elasticity, 10 ³ ksi		
Orientation	Tension	Compression
Longitudinal	10.49	10.75
Transverse	10.50	10.79
Short Transverse	10.45	10.75

TABLE 3.0622. STATIC MODULUS OF ELASTICITY OF HAND FORGINGS IN TENSION AND COMPRESSION AT ROOM TEMPERATURE (9)

Alloy 2024						
Form Sheet and Plate						
Condition	0	T3	T361	T4	T81	T861
Thickness, inch	Bend Radii Expressed in Terms of Thickness, t					
1/64	0	2.5t	3t	2.5t	4.5t	5t
1/32	0	3t	4t	3t	5.5t	6t
1/16	0	4t	5t	4t	6t	7t
1/8	0.5t	5t	6t	5t	7.5t	8.5t
3/16	1t	5t	6t	5t	8t	9.5t
1/4	1t	6t	8t	6t	9t	10t
3/8	2.5t	7t	8.5t	7t	10t	11.5t
1/2	4t	7.5t	9.5t	7.5t	10.5t	11.5t

TABLE 4.011. APPROXIMATE MINIMUM BEND RADIUS FOR 90 DEGREE COLD BEND FOR VARIOUS THICKNESSES AND HEAT-TREATED CONDITIONS (33)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

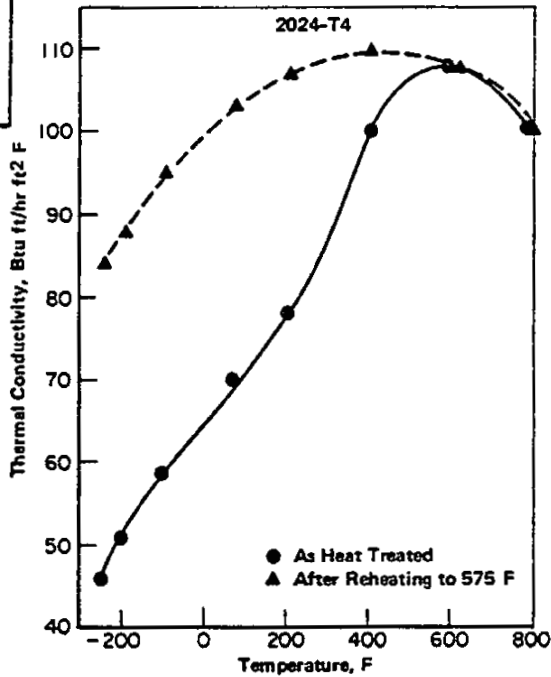


FIGURE 2.0132. EFFECT OF TEMPERATURES ON THERMAL CONDUCTIVITY (21)

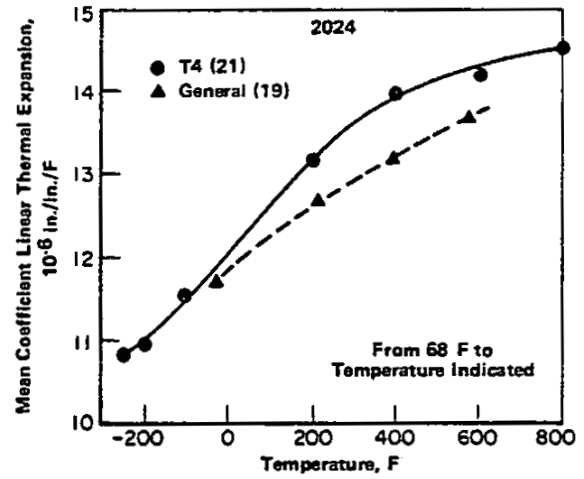


FIGURE 2.0142. EFFECT OF TEMPERATURE ON THERMAL EXPANSION (19) (21)

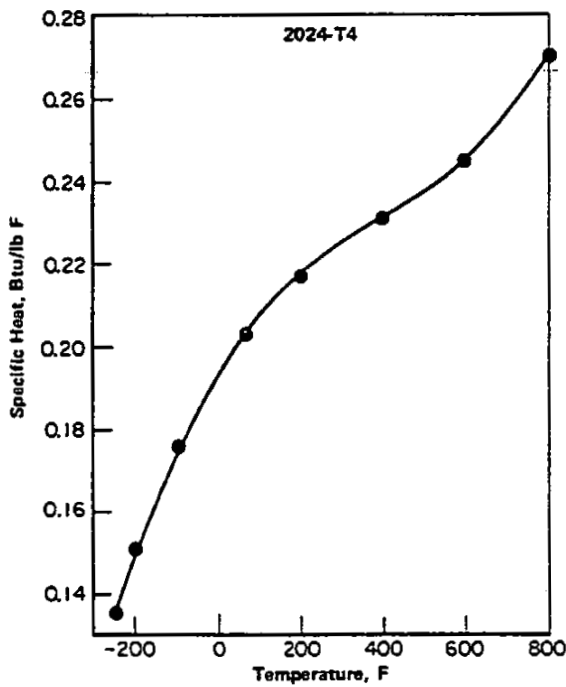


FIGURE 2.0151. EFFECT OF TEMPERATURE ON SPECIFIC HEAT (21)

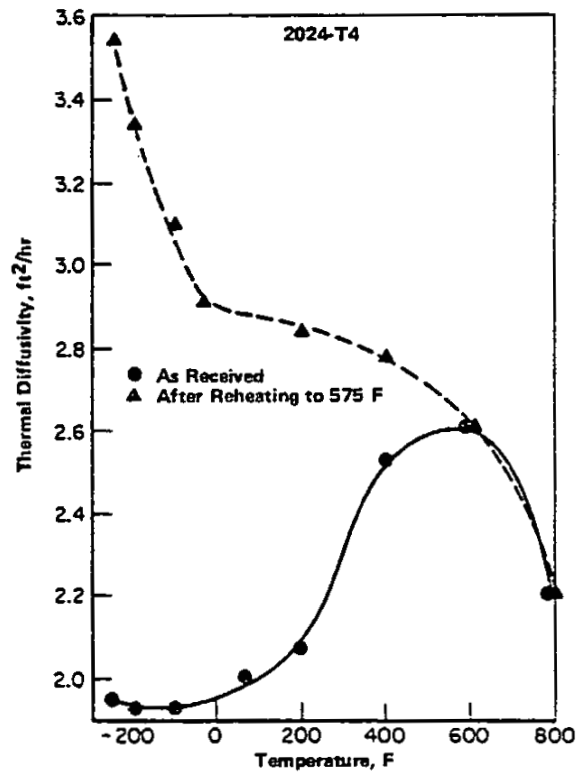


FIGURE 2.0161. EFFECT OF TEMPERATURE ON THERMAL DIFFUSIVITY (21)

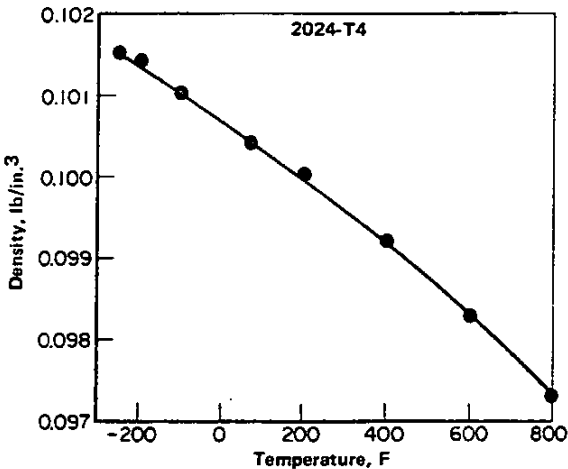
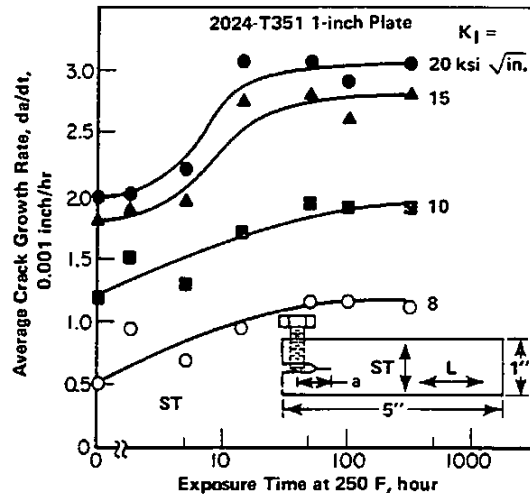


FIGURE 2.0211. EFFECT OF TEMPERATURE ON DENSITY (21)



Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

FIGURE 2.0315. EFFECTS OF PRIOR EXPOSURES AT 250 F ON STRESS-CORROSION CRACK-GROWTH RATE AT VARIOUS INITIAL LEVELS OF STRESS INTENSITY (K_I) IN DOUBLE CANTILEVER BEAM SPECIMENS LOADED IN THE SHORT TRANSVERSE (ST) DIRECTION AND INTERMITTENTLY EXPOSED 10 MIN. OF EACH HOUR IN SOLUTION AND 50 MIN. IN AIR TO 3.5 PERCENT AQUEOUS SODIUM CHLORIDE SOLUTION AT ROOM TEMPERATURE (4)

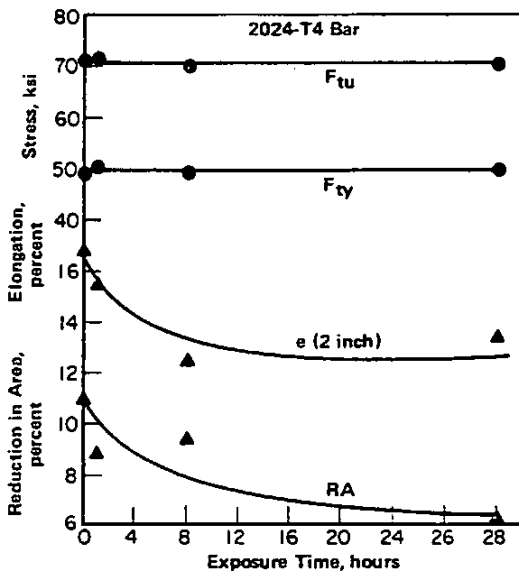


FIGURE 2.0316. EFFECTS OF EXPOSURES OF SMOOTH UNSTRESSED SPECIMENS TO SALT SPRAY AT 95 F (20 PERCENT NaCl IN DEIONIZED WATER) ON TENSILE PROPERTIES AT ROOM TEMPERATURE (2)

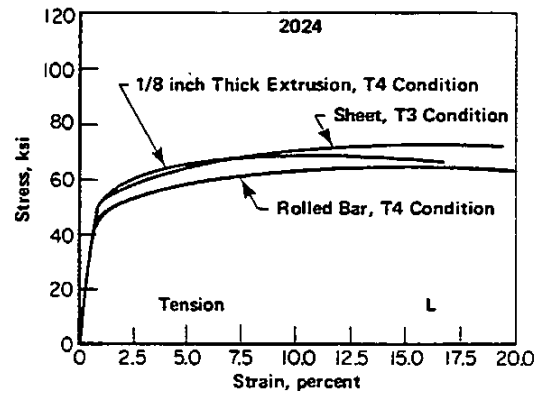


FIGURE 3.0211. COMPLETE TENSILE STRESS STRAIN CURVES FOR VARIOUS FORMS AND CONDITIONS (12)

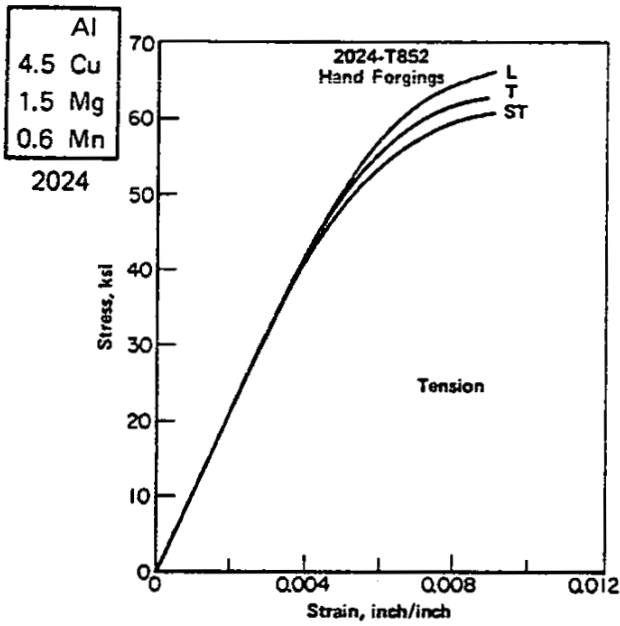


FIGURE 3.0212. TENSILE STRESS-STRAIN CURVES FOR HAND FORGINGS IN VARIOUS ORIENTATIONS, LONGITUDINAL (L), TRANSVERSE (T), AND SHORT TRANSVERSE (ST) (9)

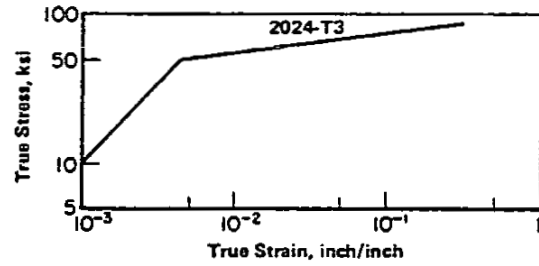


FIGURE 3.0213. TRUE-STRESS, TRUE-STRAIN CURVE (32)

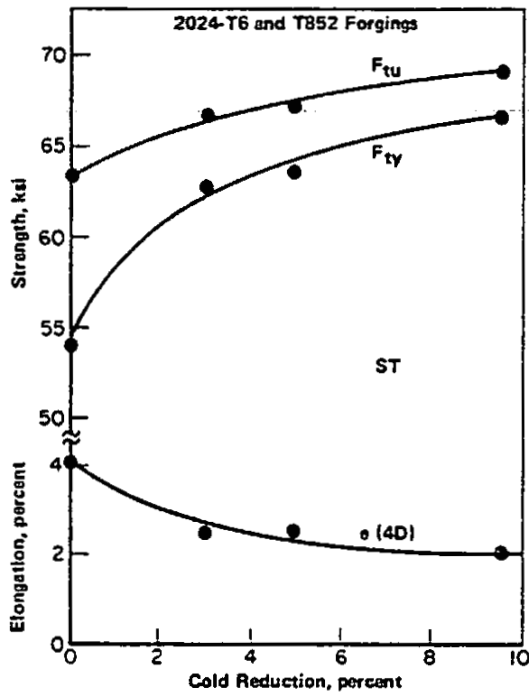


FIGURE 3.0217. EFFECTS OF COLD REDUCTION BETWEEN SOLUTION TREATMENT AND ARTIFICIAL AGING ON THE SHORT-TRANSVERSE TENSILE PROPERTIES OF FORGINGS (31)

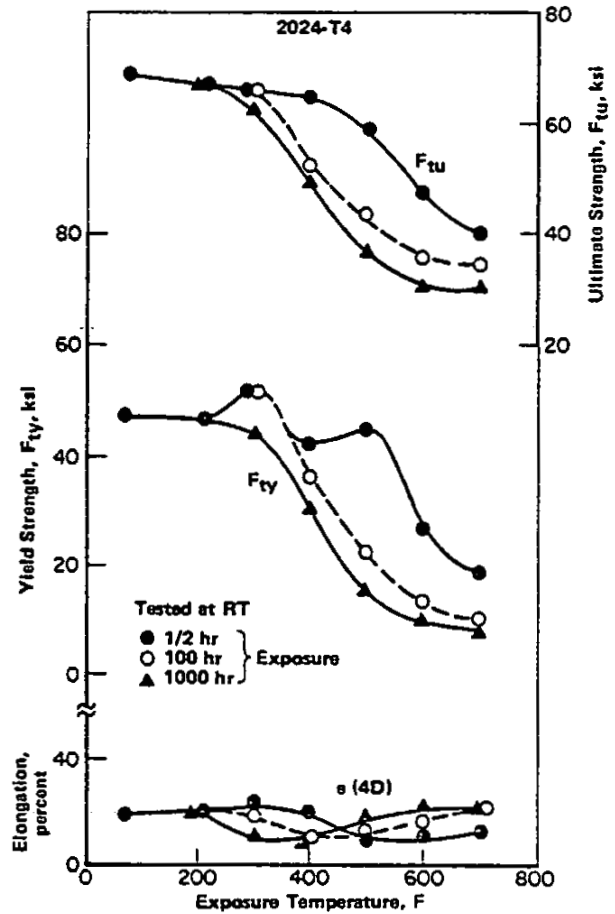


FIGURE 3.0218. EFFECTS OF EXPOSURES TO ELEVATED TEMPERATURES ON ROOM-TEMPERATURE TENSILE PROPERTIES OF ALLOY IN T4 CONDITION (38)

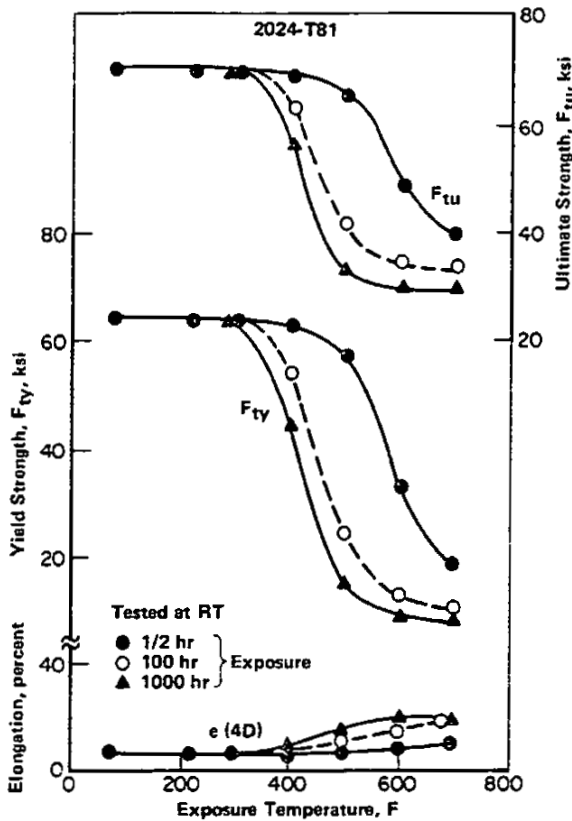


FIGURE 3.0219. EFFECTS OF EXPOSURES TO ELEVATED TEMPERATURES ON ROOM-TEMPERATURE TENSILE PROPERTIES OF ALLOY IN T81 CONDITION (39)

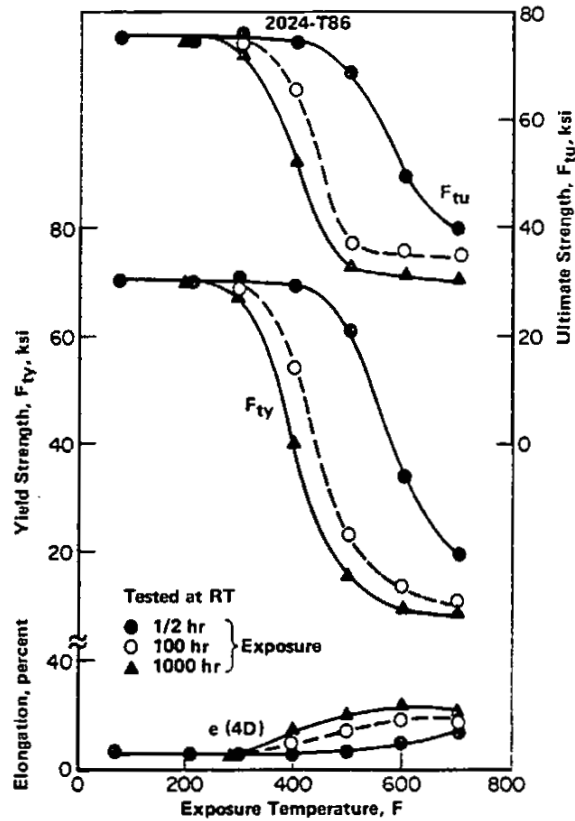


FIGURE 3.02110. EFFECTS OF EXPOSURES TO ELEVATED TEMPERATURES ON ROOM-TEMPERATURE TENSILE PROPERTIES OF ALLOY IN T86 CONDITION (40)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

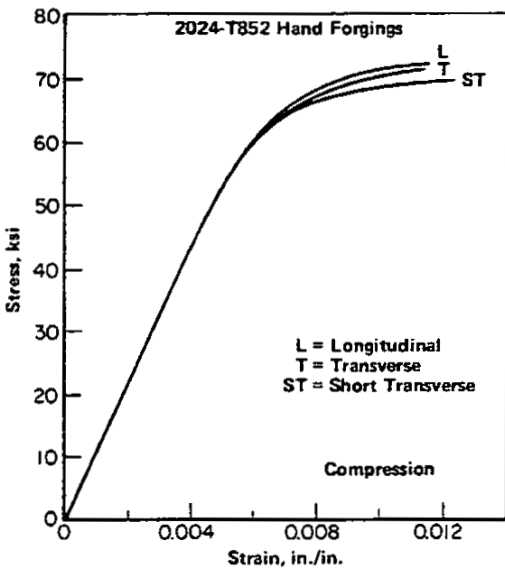


FIGURE 3.0221. COMPRESSIVE STRESS-STRAIN CURVES FOR HAND FORGINGS IN DIFFERENT ORIENTATIONS (9)

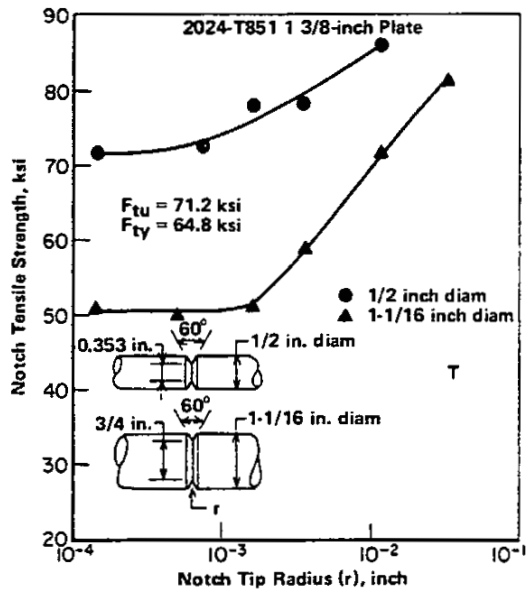


FIGURE 3.02711. EFFECTS OF SPECIMEN SIZE AND NOTCH-TIP RADIUS ON NOTCH TENSILE STRENGTH (34)

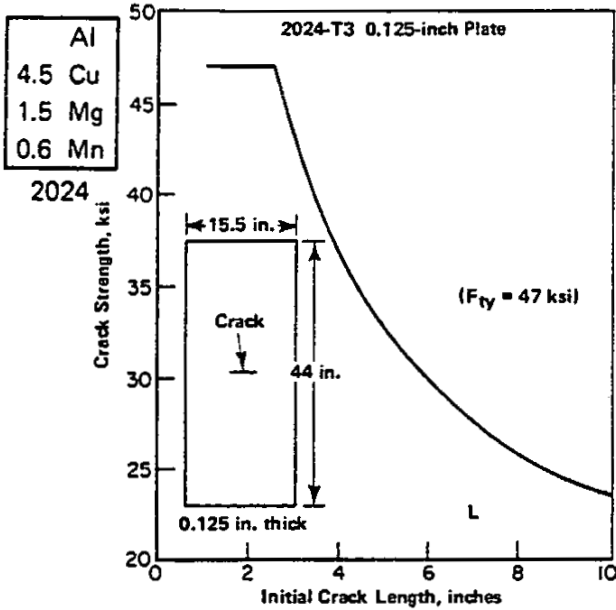


FIGURE 3.02713. EFFECT OF LENGTH OF CENTER CRACK ON CRACK STRENGTH OF 0.125-INCH PLATE (15)

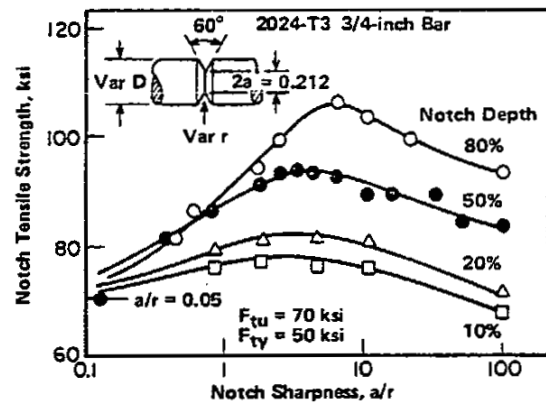


FIGURE 3.02714. EFFECTS OF NOTCH SHARPNESS AND DEPTH ON NOTCH TENSILE STRENGTH OF BAR IN T3 CONDITION (41)

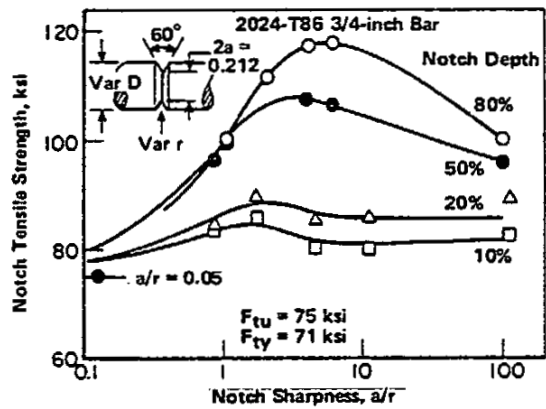


FIGURE 3.02715. EFFECTS OF NOTCH SHARPNESS AND DEPTH ON NOTCH TENSILE STRENGTH OF BAR IN T86 CONDITION (41)

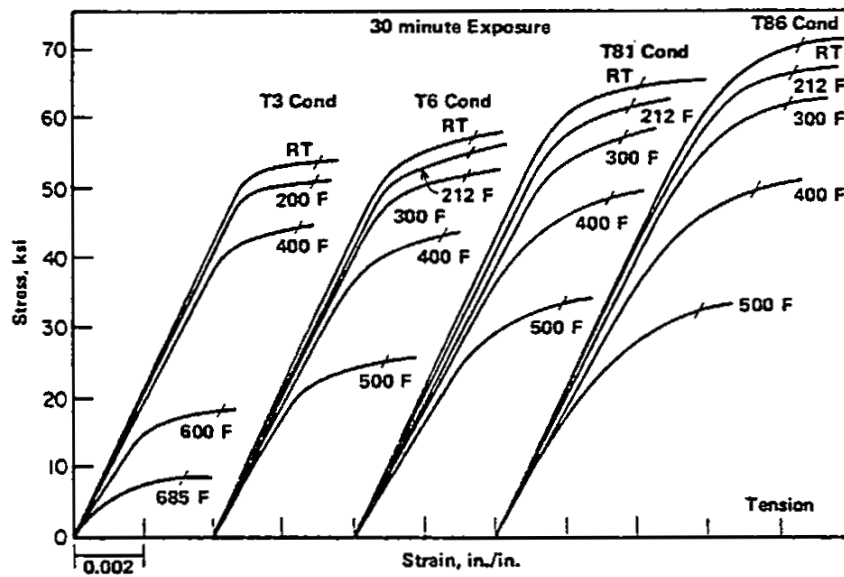


FIGURE 3.0311. STRESS-STRAIN CURVES AT VARIOUS TEMPERATURES FOR SHEET AND PLATE IN T3, T6, T81, AND T86 CONDITIONS (42)

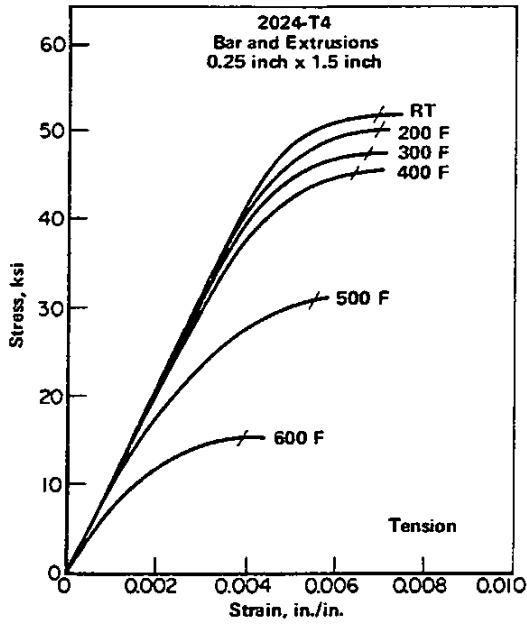


FIGURE 3.0312. STRESS-STRAIN CURVES AT VARIOUS TEMPERATURES FOR BAR AND EXTRUSIONS IN T4 CONDITION (43)

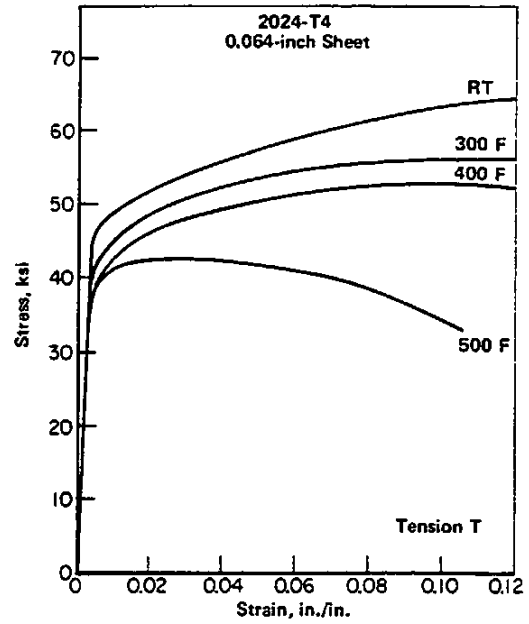


FIGURE 3.0313. COMPLETE STRESS-STRAIN CURVES AT VARIOUS TEMPERATURES FOR SHEET IN T4 CONDITION (44)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

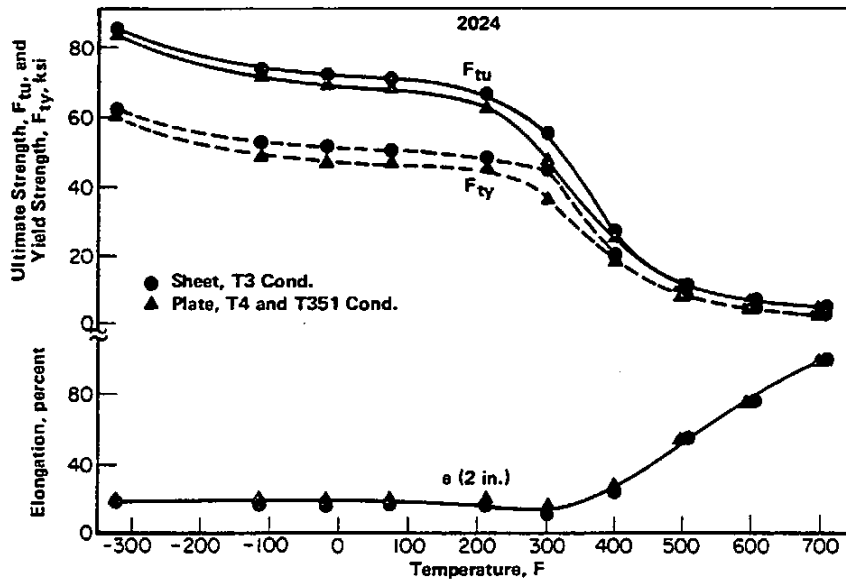


FIGURE 3.0314. EFFECTS OF TEMPERATURES FROM -320 TO 700 F ON TENSILE PROPERTIES OF SHEET AND PLATE AFTER 10,000 HOURS' EXPOSURE TIME AT TEMPERATURE (16) (26)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

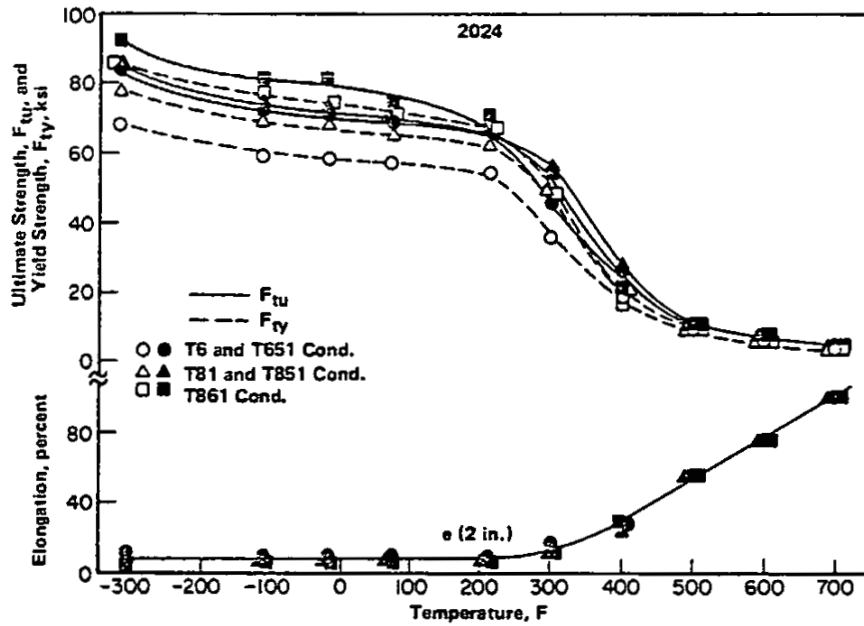


FIGURE 3.0315. TYPICAL TENSILE PROPERTIES AT TEMPERATURES FROM -320 TO 700 F FOR WROUGHT PRODUCTS IN SEVERAL HEAT-TREATED CONDITIONS AFTER 10,000 HOURS' EXPOSURE TIME AT TEMPERATURE (16) (26)

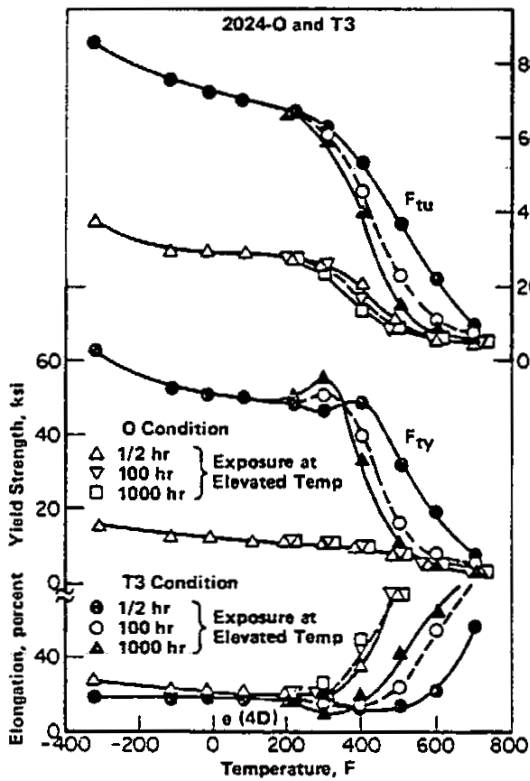


FIGURE 3.0316. EFFECTS OF TEMPERATURE AND EXPOSURE TIME AT TEMPERATURE ON TENSILE PROPERTIES OF ALLOY IN O AND T3 CONDITIONS (45) (46)

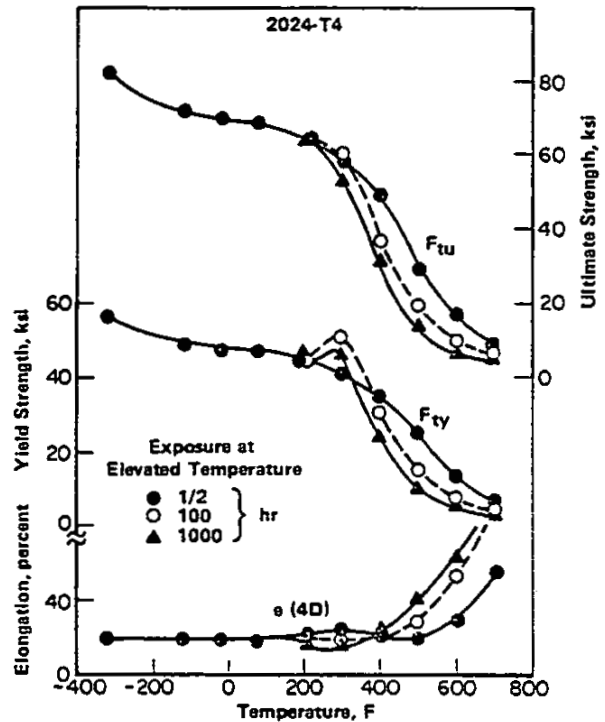


FIGURE 3.0317. EFFECTS OF TEMPERATURE AND EXPOSURE TIME AT TEMPERATURE ON TENSILE PROPERTIES OF ALLOY IN T4 CONDITION (38)

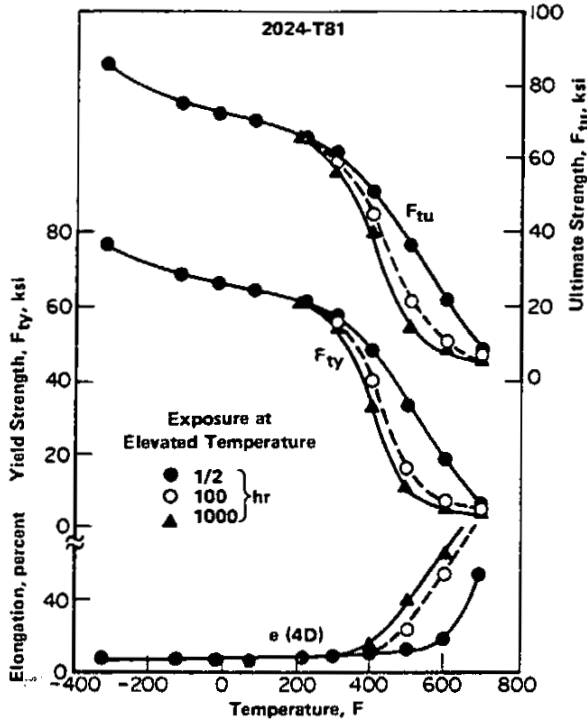


FIGURE 3.0318. EFFECTS OF TEMPERATURE AND EXPOSURE TIME AT TEMPERATURE ON TENSILE PROPERTIES OF ALLOY IN T81 CONDITION (39)

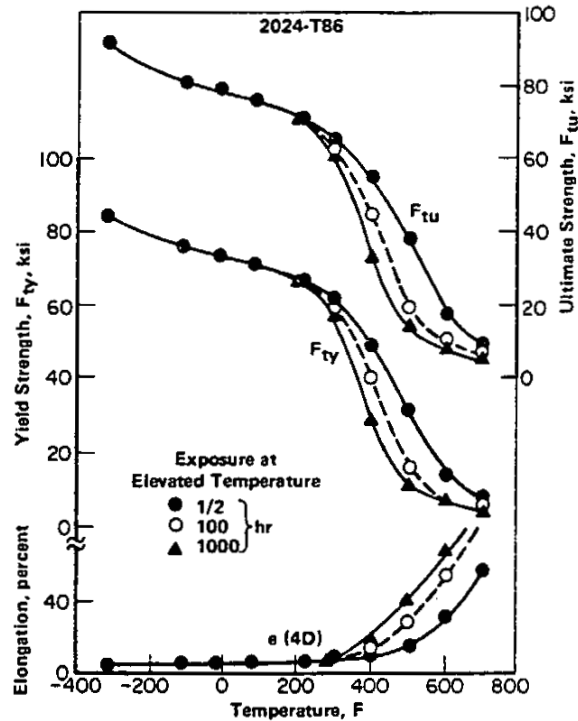


FIGURE 3.0319. EFFECTS OF TEMPERATURE AND EXPOSURE TIME AT TEMPERATURE ON TENSILE PROPERTIES OF ALLOY IN T86 CONDITION (40)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

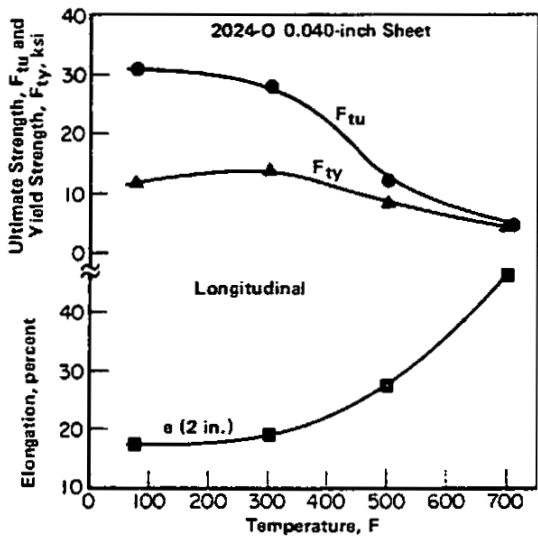


FIGURE 3.03110. EFFECTS OF TEMPERATURES FROM 75 TO 700 F ON TENSILE PROPERTIES OF ANNEALED SHEET (3)

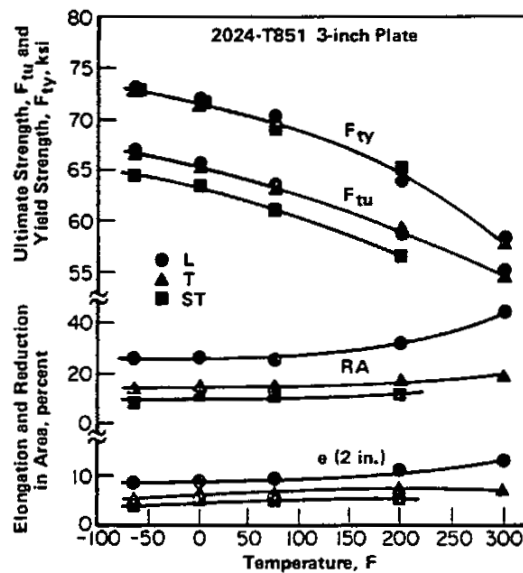


FIGURE 3.03111. EFFECTS OF TEMPERATURES FROM -65 TO 300 F AND OF LOADING ORIENTATION ON TENSILE PROPERTIES OF PLATE IN THE T851 CONDITION (8)

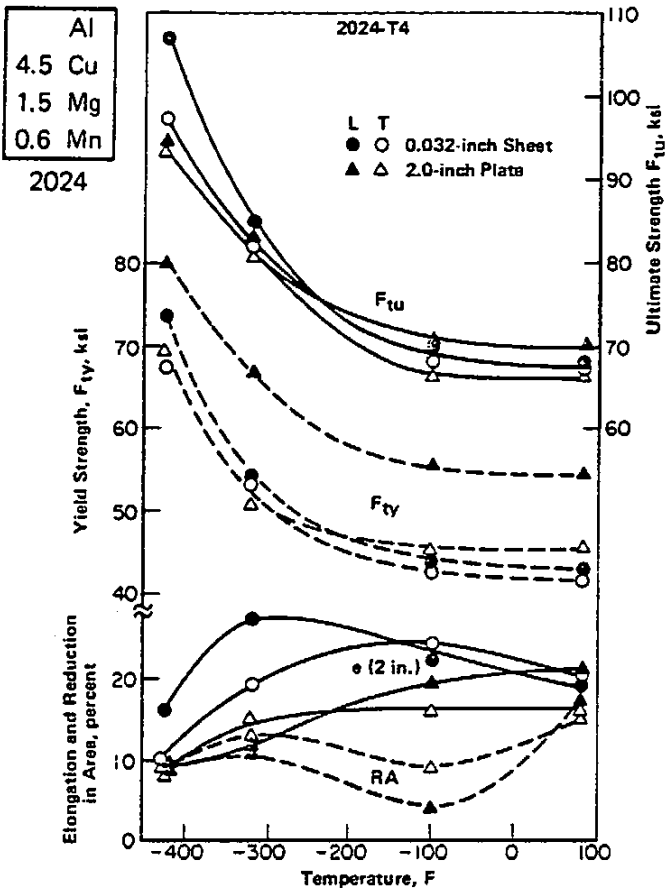


FIGURE 3.03112. EFFECTS OF TEMPERATURES FROM -423 TO 78 F ON TENSILE PROPERTIES OF SHEET AND PLATE IN THE T4 CONDITION (10)

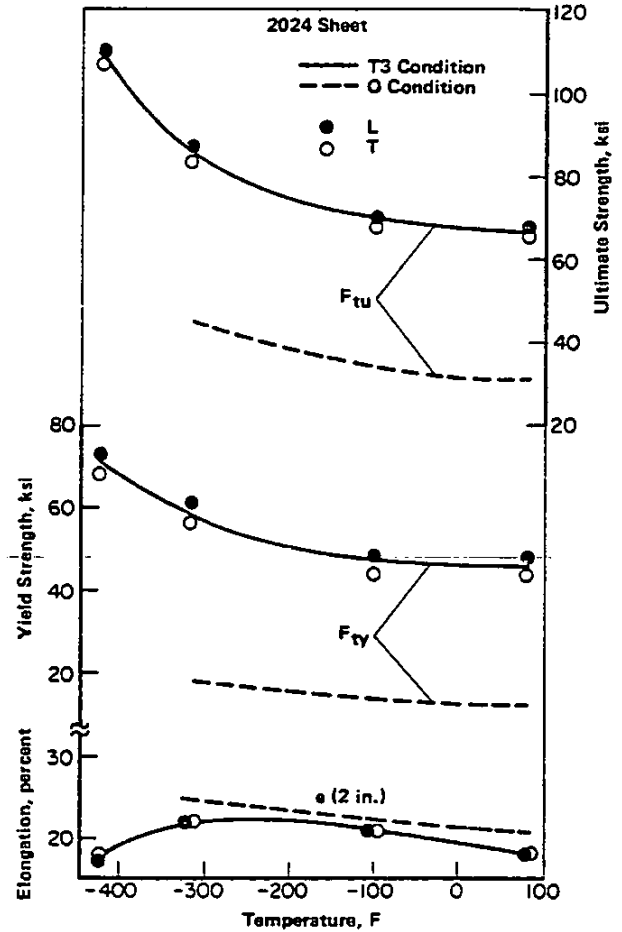


FIGURE 3.03113. EFFECTS OF TEMPERATURES FROM -423 TO 78 F ON TENSILE PROPERTIES OF SHEET IN THE T3 AND O CONDITIONS (10)

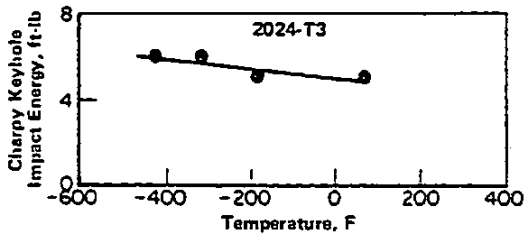


FIGURE 3.0331. EFFECT OF LOW TEST TEMPERATURES ON IMPACT STRENGTH OF ALLOY IN T3 CONDITION (47)

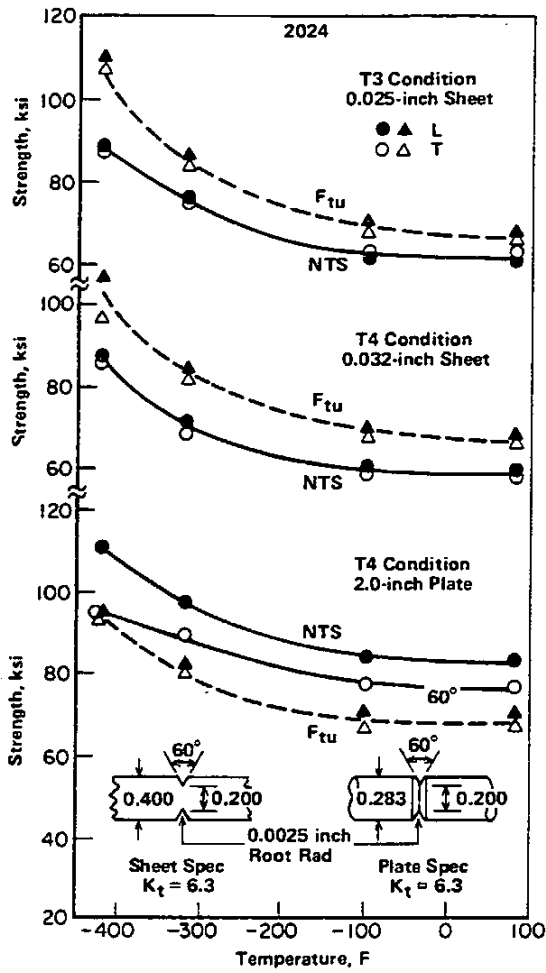


FIGURE 3.03711. COMPARISON OF LOW-TEMPERATURE NOTCH TENSILE STRENGTH AND ULTIMATE TENSILE STRENGTH OF SHEET AND PLATE IN T3 AND T4 CONDITIONS (10)

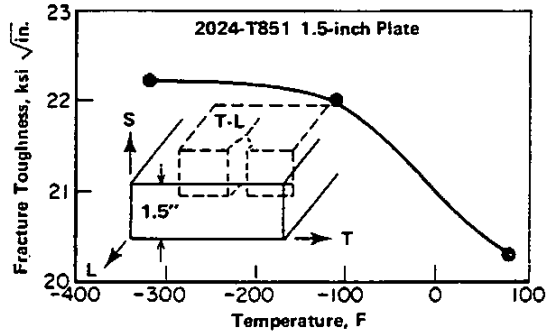


FIGURE 3.03722. EFFECTS OF TEMPERATURES FROM 75 TO -320 F ON FRACTURE TOUGHNESS (24)

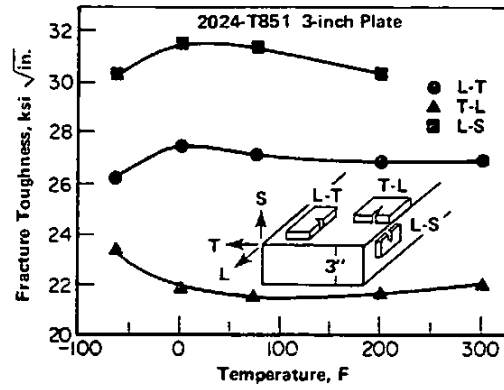


FIGURE 3.03721. EFFECTS OF TEMPERATURES FROM -65 TO 300 F AND OF LOADING ORIENTATION ON FRACTURE TOUGHNESS (8)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

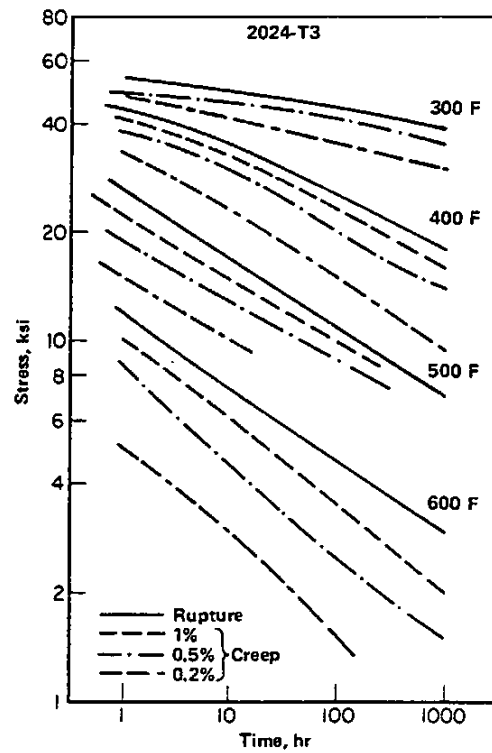


FIGURE 3.041. CREEP AND CREEP-RUPTURE CURVES AT 300 TO 600 F FOR ALLOY IN T3 CONDITION (45)

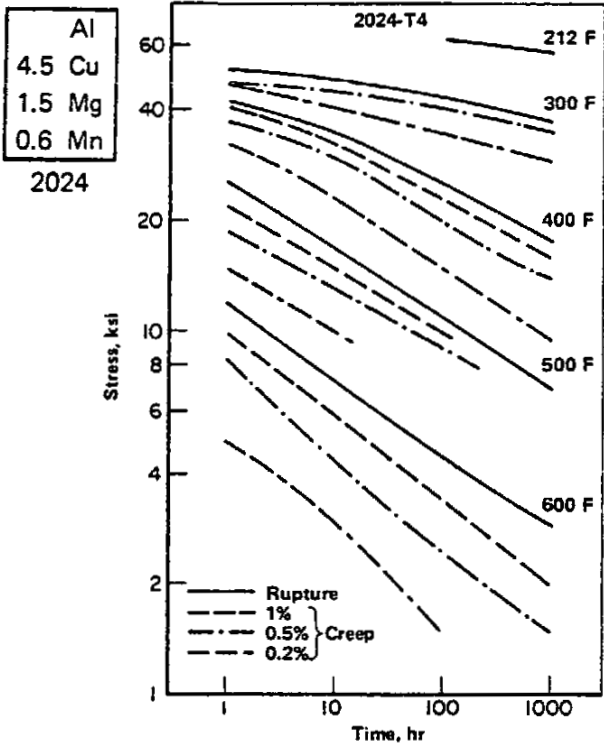


FIGURE 3.042. CREEP AND CREEP-RUPTURE CURVES AT 212 TO 600 F FOR ALLOY IN T4 CONDITION (38)

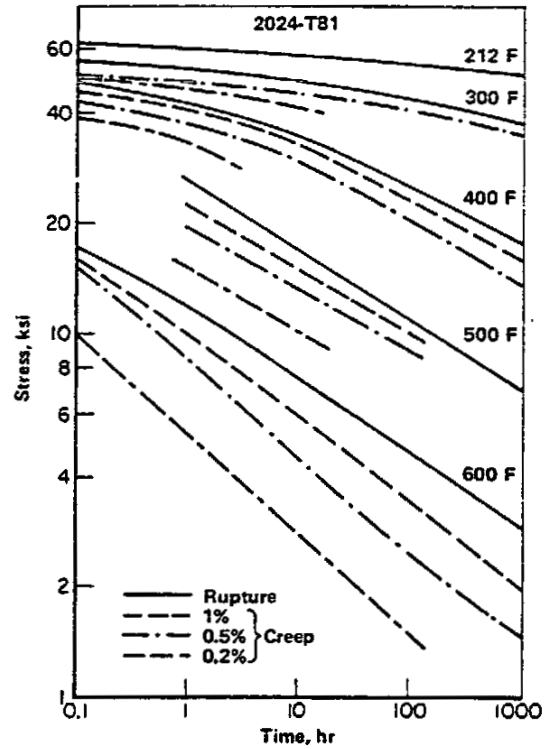


FIGURE 3.043. CREEP AND CREEP-RUPTURE CURVES AT 212 TO 600 F FOR ALLOY IN T81 CONDITION (39)

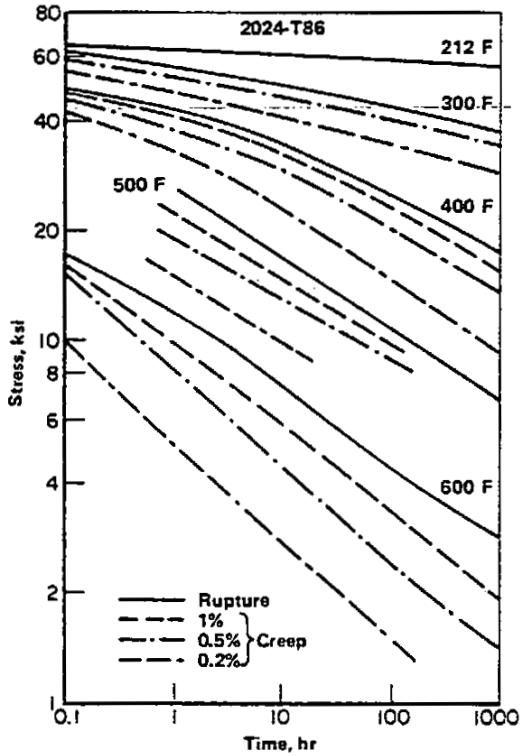


FIGURE 3.044. CREEP AND CREEP-RUPTURE CURVES AT 212 TO 600 F FOR ALLOY IN T86 CONDITION (40)

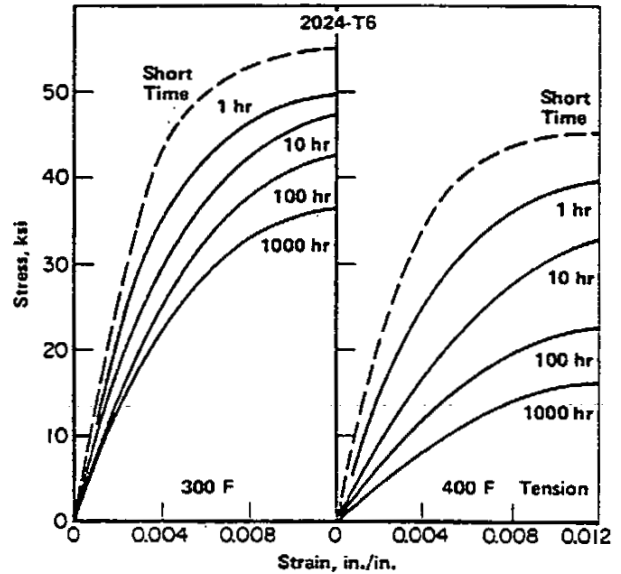


FIGURE 3.045. ISOCHRONOUS STRESS-STRAIN CURVES IN TENSION AT 300 AND 400 F FOR ALLOY IN T6 CONDITION (48)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

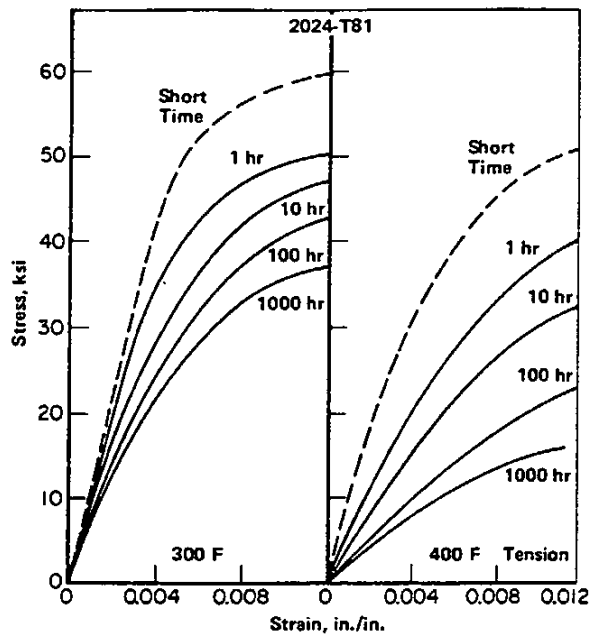


FIGURE 3.046. ISOCHRONOUS STRESS-STRAIN CURVES IN TENSION AT 300 AND 400 F FOR ALLOY IN T81 CONDITION (48)

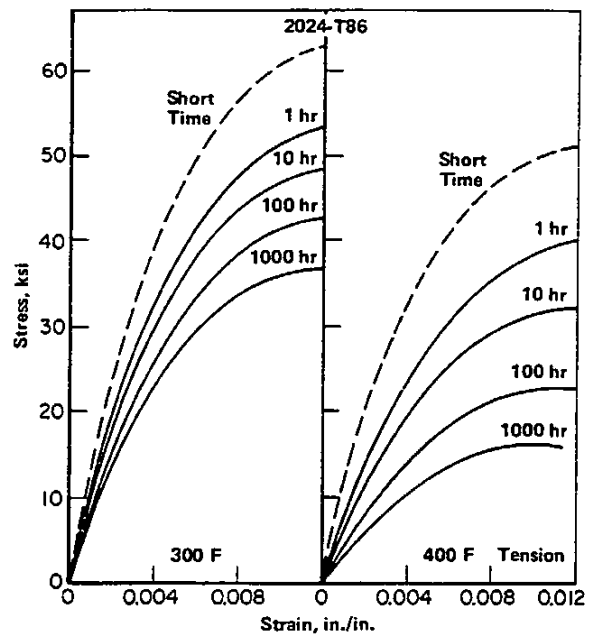


FIGURE 3.047. ISOCHRONOUS STRESS-STRAIN CURVES IN TENSION AT 300 AND 400 F FOR ALLOY IN T86 CONDITION (48)

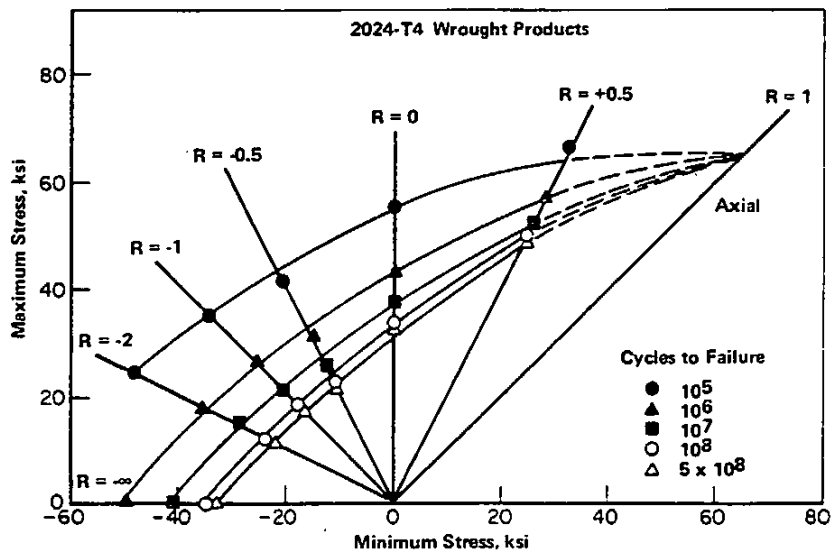


FIGURE 3.051. MODIFIED GOODMAN DIAGRAM SHOWING FATIGUE PROPERTIES OF WROUGHT PRODUCTS IN T4 CONDITION (27)

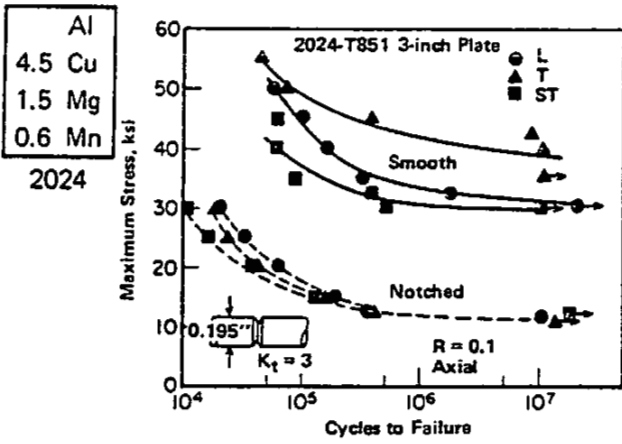


FIGURE 3.053. AXIAL FATIGUE PROPERTIES OF SMOOTH AND NOTCHED SPECIMENS TAKEN FROM PLATE IN DIFFERENT ORIENTATIONS (8)

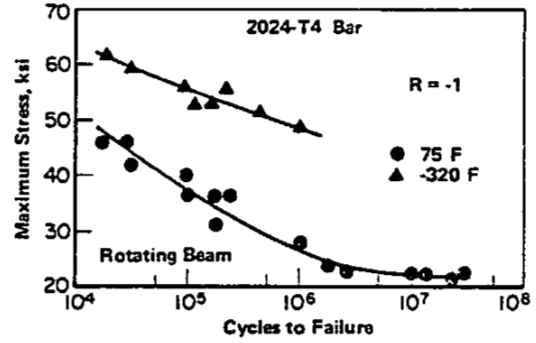


FIGURE 3.054. ROTATING BEAM FATIGUE LIFE OF BAR AT ROOM TEMPERATURE AND -320 F (11)

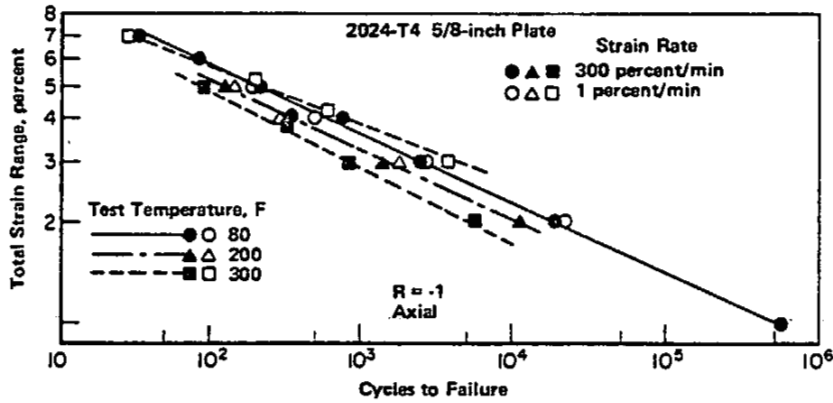


FIGURE 3.055. EFFECTS OF TOTAL STRAIN RANGE PER CYCLE, TEMPERATURE, AND STRAIN RATE ON FATIGUE LIFE (18)

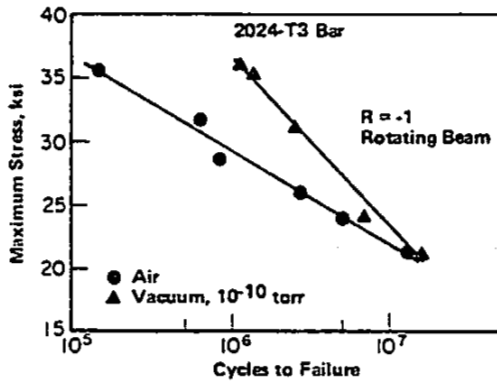


FIGURE 3.056. EFFECTS OF VACUUM VERSUS AIR ENVIRONMENT ON THE ROTATING-BEAM FATIGUE PROPERTIES OF SMOOTH SPECIMENS (5)

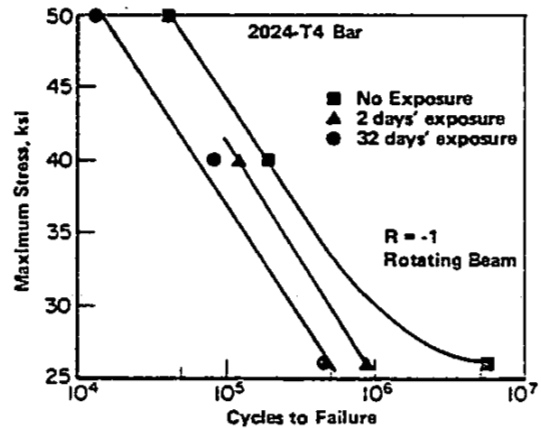


FIGURE 3.057. EFFECTS OF PRIOR EXPOSURE TO SALT SPRAY AT 95 F (20 PERCENT NaCl IN DEIONIZED WATER) ON ROTATING-BEAM FATIGUE PROPERTIES OF SMOOTH SPECIMENS AT ROOM TEMPERATURE (2)

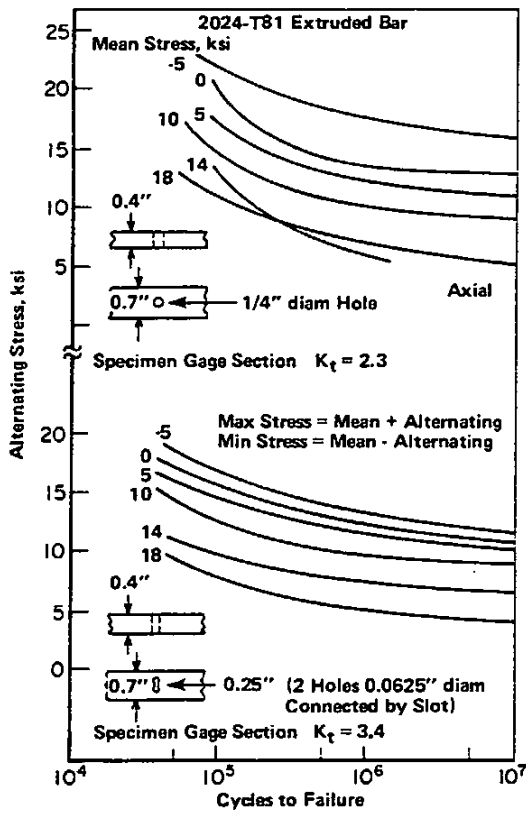


FIGURE 3.058. EFFECTS OF VARIATIONS IN MEAN STRESS ON AXIAL FATIGUE PROPERTIES OF NOTCHED SPECIMENS (6)

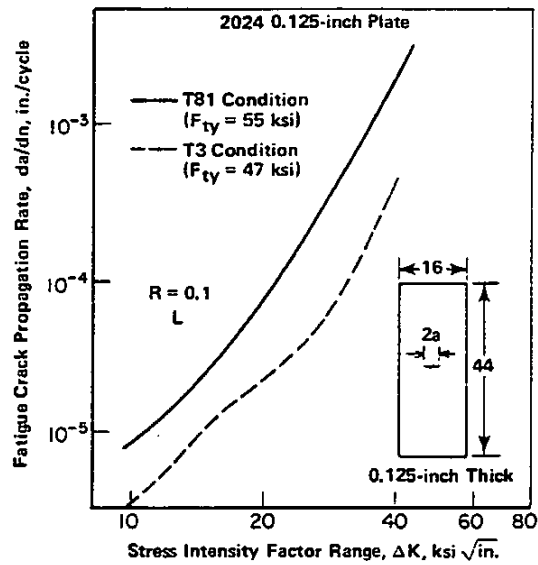


FIGURE 3.059. FATIGUE-CRACK PROPAGATION RATE AS A FUNCTION OF STRESS-INTENSITY-FACTOR RANGE IN 0.125 INCH PLATE IN TWO HEAT-TREATED CONDITIONS (15)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

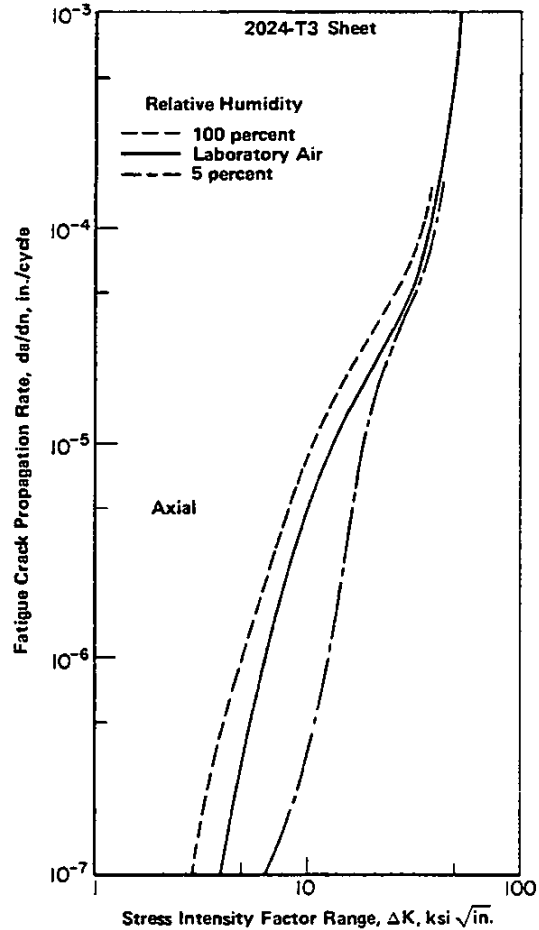


FIGURE 3.0510. FATIGUE-CRACK GROWTH RATE AS A FUNCTION OF STRESS-INTENSITY-FACTOR RANGE IN AIR ENVIRONMENTS WITH VARIOUS RELATIVE HUMIDITIES (20)

Al
4.5 Cu
1.5 Mg
0.6 Mn
2024

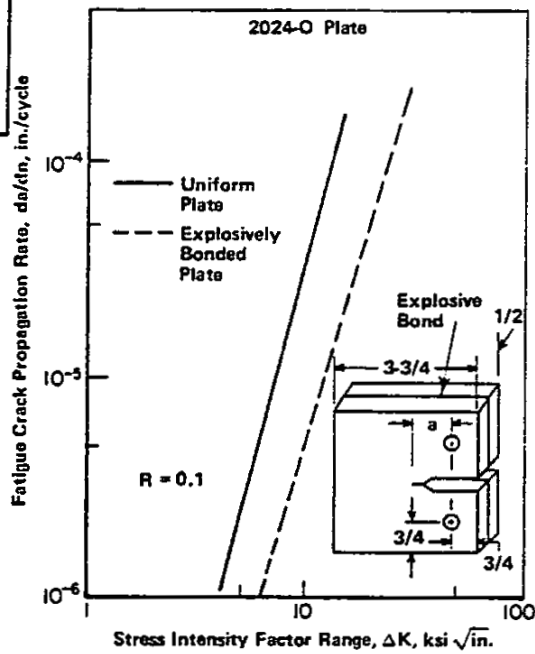


FIGURE 3.0511. FATIGUE-CRACK PROPAGATION RATE AS A FUNCTION OF STRESS-INTENSITY-FACTOR RANGE IN EXPLOSIVELY BONDED PLATE COMPARED WITH UNIFORM PLATE IN THE ANNEALED CONDITION (7)

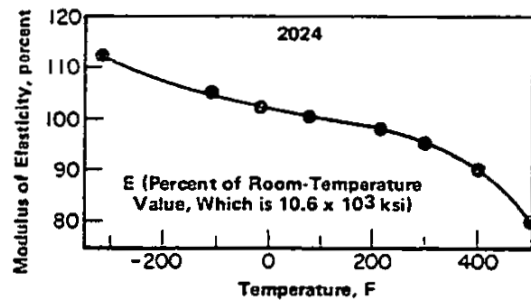


FIGURE 3.0623. EFFECT OF TEMPERATURE ON MODULUS OF ELASTICITY RELATIVE TO ROOM-TEMPERATURE VALUE (20)

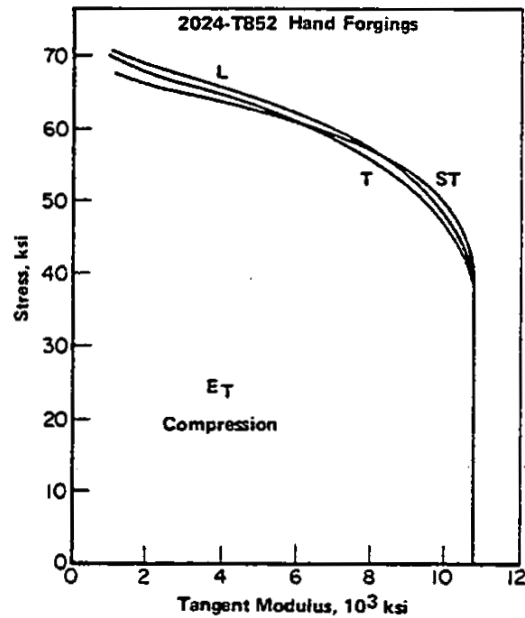


FIGURE 3.0641. TANGENT MODULUS CURVES FOR HAND FORGINGS IN DIFFERENT ORIENTATIONS (9)

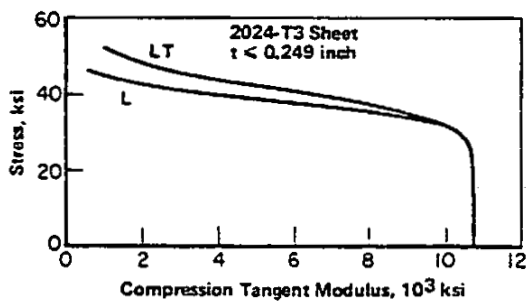


FIGURE 3.0642. TYPICAL COMPRESSIVE TANGENT-MODULUS CURVES FOR 2024-T3 ALUMINUM ALLOY AT ROOM TEMPERATURE (49)

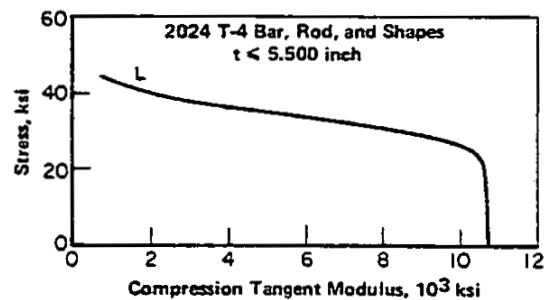


FIGURE 3.0643. TYPICAL COMPRESSIVE TANGENT-MODULUS CURVES FOR 2024-T4 ALUMINUM ALLOY AT ROOM TEMPERATURE (49)

1. GENERAL

In order to improve the corrosion resistance of 2024 sheet, strip and plate it is clad with high purity (99.3%+) aluminum (230). This imparts to Clad 2024 a corrosion resistance equal to that of pure aluminum, unless it is overheated. The cladding reduces the strength of 2024 by about 5 percent. In most respects Clad 2024 behaves in the same manner as bare 2024, sheet, strip and plate.

- 1.01 Commercial Designation. Clad 2024.
- 1.02 Alternate Designations. Alclad 2024, Clad 24 S (obsolete).
- 1.03 Specifications. Table 1.03.

AMS	Form	Military
4034	Plate, (T351 Cond)	
4036	Clad one side sheet (T3 Cond) plate (T4 Cond)	
4040 E	Sheet, plate (0 Cond)	
4041 F	Sheet, (T3 Cond) plate, (T4 Cond)	
4042 E	Sheet, plate, (T36 Cond)	
-	Sheet, plate (T6, T81, T86 Cond)	MIL-A-8705

- 1.04 Composition. Table 1.04.

Source	AMS (1)			
	Core		Cladding*	
	Min	Max	Min	Max
Copper	3.8	4.9	-	0.10
Magnesium	1.2	1.8	-	-
Manganese	0.30	0.9	-	0.05
Iron	-	0.50	-	0.7
Silicon	-	0.50	-	0.10
Zinc	-	0.25	-	-
Chromium	-	0.10	-	-
Other Impurities	-	-	-	-
each	-	0.05	-	0.05
total	-	0.15	-	0.15
Aluminum	Balance		99.3	

* The nominal cladding thickness is between 5 and 1.5 percent of the total thickness on each side, depending on the total thickness of the product

- 1.05 Heat Treatment. Clad 2024 is heat treated under the same conditions as 2024, but the shortest heat treatment time consistent with securing the required properties should be used. Prolonged heating or repeated reheat treatments which cause diffusion of alloying elements into the coating and impair the resistance to corrosion should be avoided. See 4.043.
- 1.06 Hardenability. See 2024.
- 1.07 Forms and Conditions Available
- 1.071 Alloy is available in the full commercial range of sizes for sheet and plate.
- 1.072 Conditions available, Table 1.072.

Source	(3, p. 32-34)
Form	Condition
Sheet	0, T3, T36, T4, T42, T6, T81, T851, T86
Plate	0, T36, T351, T4, T42, T6, T81, T851, T86

- 1.08 Melting and Casting Practice. Clad sheet is produced today exclusively by rolling a sandwich, rather than by casting.
- 1.09 Special Considerations. See 2024 also. Prolonged heating or repeated reheat treatments of clad material will cause diffusion of alloying elements into the cladding and impair its resistance to corrosion.

2. PHYSICAL AND CHEMICAL PROPERTIES

- 2.01 Thermal Properties. See 2024 also.
- 2.011 Thermal conductivity. T3 and T4 Conditions, 70.2 Btu ft per (hr sq ft F). T6 Condition, 84.7 Btu ft per (hr sq ft F).
- 2.012 Thermal expansion from RT to 212 F, 12.6×10^{-6} in per in per F.
- 2.013 Specific heat. 0.23 Btu per (lb F).
- 2.03 Chemical Properties
- 2.031 Corrosion resistance
- 2.0311 The general corrosion resistance of clad material is considerably superior to that of bare metal as the cladding possesses an inherent corrosion resistance comparable to that of pure aluminum. Since the cladding is more anodic than the core material, the core is protected even when it is exposed.
- 2.0312 The corrosion resistance is impaired by copper diffusion into the cladding during heating and heat treating for times exceeding the required minimum time or repeated heat treating.
- 2.032 Oxidation resistance. See 2024.

- 3. MECHANICAL PROPERTIES. See 2024 also and deduct 3 to 10 percent from strength values, depending on thickness of cladding.

- 3.01 Specified Mechanical Properties
- 3.011 Aluminum Association specified mechanical properties for clad sheet and plate in 0 Condition, Table 3.011.

Source	(2, p. 32)				
	Al-4.5Cu-1.5Mg-0.6Mn				
Form	Sheet, Plate				
Condition	0*				
Thickness - in	0.008 to 0.009	0.010 to 0.032	0.033 to 0.062	0.063 to 0.499	0.500 to 1.750
F _{tu} , max - ksi	30	30	30	32	32
F _{ty} , max - ksi	14	14	14	14	-
e(2 in), min-percent	7	8	10	12	8

* For all standard widths and clad thickness.

- 3.012 Aluminum Association specified mechanical properties for clad sheet in T3 Condition and clad sheet and plate in T36 Condition, Table 3.012.
- 3.013 Aluminum Association specified mechanical properties for clad coiled sheet in T4 Condition, clad plate in T4 and T357 Condition and clad sheet and plate in T42 and T6 Condition, Table 3.013.
- 3.014 Aluminum Association specified mechanical properties for clad sheet and plate in T81 and T851 Condition and T86 Condition up to width of 48 inches, Table 3.014.
- 3.015 Aluminum Association specified mechanical properties for clad sheet and plate in T86 Condition over 48 inches width, Table 3.015.
- 3.02 Mechanical Properties at Room Temperature. See 3.03 also.
- 3.021 Stress strain curves in tension and compression for sheet in T3 and T36 Conditions, Fig. 3.021.
- 3.022 Effect of stretching on tensile and compressive yield strengths of sheet in the T4 Condition, Fig. 3.022.
- 3.03 Mechanical Properties at Various Temperatures
- 3.031 Short time tension properties
- 3.0311 Stress strain curves for sheet in T3 Condition at room and elevated temperatures, Fig. 3.0311.
- 3.0312 Stress strain curves for sheet in T81 and T86 Conditions at room and elevated temperatures, Fig. 3.0312.
- 3.0313 Effect of exposure and test temperature on tensile properties of sheet in T3 Condition, Fig. 3.0313.
- 3.0314 Effect of exposure and test temperature on tensile properties of sheet in T81 Condition, Fig. 3.0314.
- 3.0315 Effect of exposure and test temperature on tensile properties of sheet in T86 Condition, Fig. 3.0315.

Al
4.5 Cu
1.5 Mg
0.6 Mn

CLAD 2024

Al
4.5 Cu
1.5 Mg
0.6 Mn

CLAD 2024

TABLE 3.012

Source	(2, p. 32, 33)															
Alloy	Al-4.5Cu-1.5Mg-0.6Mn															
Form	Flat sheet							Flat sheet and plate*								
Condition	T3							T36								
Width - in	All							≤ 48				> 48 ≤ 60				> 60
Clad thickness - %	5	5	5	2 1/2	1 1/2	5	2 1/2	1 1/2	5	2 1/2	1 1/2	1 1/2	2 1/2	1 1/2	1 1/2	
Thickness - in	0.008 to 0.009	0.010 to 0.020	0.021 to 0.052	0.063 to 0.249	0.188 to 0.249	0.020 to 0.062	0.063 to 0.499	0.188 to 0.499	0.020 to 0.052	0.053 to 0.499	0.188 to 0.249	0.250 to 0.499	0.063 to 0.499	0.188 to 0.249	0.250 to 0.499	
F _{tu} min -ksi	58	59	59	62	63	62	66	67	61	65	66	66	64	65	65	
F _{ty} min -ksi	39	39	39	40	41	48	50	51	47	49	50	49	48	49	48	
e(2 in) min-percent	10	12	15	15	15	8	9	9	8	9	9	9	9	9	9	

* For plate 0.500 in or over in thickness the clad has been removed to prepare specimens and therefore the properties are for core material only. The actual composite properties would be slightly lower. For values see 2024.

TABLE 3.013

Source	(2, p. 33, 34)														
Alloy	Al-4.5Cu-1.5Mg-0.6Mn														
Form	Coiled sheet			Plate*		Sheet and plate*							Sheet and plate		
Condition	T4			T4, T351		T42							T6		
Width - in	All			All		All							All		
Clad thickness - %	5	5	2 1/2	2 1/2	1 1/2	5	5	5	2 1/2	1 1/2	2 1/2	1 1/2	5	2 1/2	1 1/2
Thickness - in	0.010 to 0.020	0.021 to 0.062	0.068 to 0.128	0.250 to 0.499	0.250 to 0.499	0.008 to 0.009	0.010 to 0.020	0.021 to 0.062	0.053 to 0.249	0.188 to 0.249	0.250 to 0.499	0.250 to 0.499	0.010 to 0.062	0.063 to 0.499	0.188 to 0.499
F _{tu} min -ksi	58	58	61	62	63	55	55	56	59	60	62	63	60	62	62
F _{ty} min -ksi	37	37	38	40	40	34	34	34	36	37	38	38	47	49	49
e(2 in) min-percent	12	15	15	12	12	10	12	15	15	15	12	12	5	5	5

* See footnote for Table 3.012.

TABLE 3.014

Source	(2, p. 34)														
Alloy	Al-4.5Cu-1.5Mg-0.6Mn														
Form	Flat sheet and plate*														
Condition	T81 and T851					T85									
Width - in	All					≤ 30					> 30 ≤ 48				
Clad thickness - %	5	2 1/2	1 1/2	5	2 1/2	1 1/2	2 1/2	1 1/2	5	2 1/2	1 1/2	2 1/2	1 1/2	2 1/2	1 1/2
Thickness - in	0.010 to 0.062	0.063 to 0.499	0.188 to 0.499	0.020 to 0.249	0.063 to 0.249	0.188 to 0.249	0.250 to 0.499	0.250 to 0.499	0.020 to 0.062	0.063 to 0.249	0.188 to 0.249	0.250 to 0.499	0.250 to 0.499	0.020 to 0.062	0.063 to 0.249
F _{tu} min -ksi	62	65	66	66	70	71	70	71	66	70	71	69	70	69	70
F _{ty} min -ksi	54	56	57	62	66	67	65	66	62	65	66	64	66	64	65
e(2 in) min-percent	5	5	5	3	4	4	4	4	3	4	4	4	4	4	4

* See footnote for Table 3.012.

TABLE 3.015

Source	(2, p. 34)									
Alloy	Al-4.5Cu-1.5Mg-0.6Mn									
Form	Flat sheet and plate*									
Condition	T86									
Width - in	> 48 ≤ 60					> 60				
Clad thickness - %	5	2 1/2	1 1/2	2 1/2	1 1/2	2 1/2	1 1/2	2 1/2	1 1/2	2 1/2
Thickness - in	0.020 to 0.062	0.053 to 0.249	0.188 to 0.249	0.250 to 0.499	0.250 to 0.499	0.063 to 0.249	0.188 to 0.249	0.250 to 0.499	0.250 to 0.499	0.063 to 0.249
F _{tu} min -ksi	64	69	70	68	69	69	70	68	69	69
F _{ty} min -ksi	58	65	66	63	64	64	65	62	65	62
e(2 in) min-percent	3	4	4	4	4	4	4	4	4	4

* See footnote for Table 3.012.

- 3.032 Short time properties other than tension
- 3.0321 Stress strain curves in compression for sheet in T3 Condition at room and elevated temperatures, Fig. 3.0321.
- 3.0322 Stress strain curves in compression for sheet in T81 and T86 Conditions at room and elevated temperatures, Fig. 3.0322.
- 3.0323 Effect of exposure and test temperature on compressive yield strength of sheet in T3, T81 and T86 Conditions, Fig. 3.0323.
- 3.0324 Effect of exposure and test temperature on shear strength of sheet in T3, T81 and T86 Conditions, Fig. 3.0324.
- 3.0325 Effect of exposure and test temperature on bearing properties of sheet in T3 Condition, Fig. 3.0325.
- 3.0326 Effect of exposure and test temperature on bearing properties of sheet in T81 and T86 Conditions, Fig. 3.0326.
- 3.033 Static stress concentration effects
- 3.04 Creep and Creep Rupture Properties. See 2024.
- 3.041 Short time total strain curves for sheet in T81 Condition at 300 to 600 F, Fig. 3.041.
- 3.042 Short time total strain curves for sheet in T86 Condition at 300 to 600 F, Fig. 3.042.
- 3.05 Fatigue Properties. See 2024 also.
- 3.051 Fatigue strength of alloy in various Conditions, Table 3.051.
- 3.06 Elastic Properties. See 2024 also.
- 3.061 Clad aluminum alloys have two separate modulus values. The initial, or primary, modulus is substantially the same as that of the core material. It applies up to stresses near the yield strength of the cladding. Above this point the material exhibits a secondary modulus up to the elastic limit of the core material. The secondary modulus is from

TABLE 3.051

Source		(3, p.142)							
Form		Sheet							
Condition	Temp F	Method	Stress Ratio		Fatigue Strength - ksi				
			A	R	10 ⁵	10 ⁶	10 ⁷	10 ⁸	5x10 ⁸
T3	RT	Rot beam	∞	-1	32	20	15	13	12.5
T36					32	20.5	16	13.5	13.5
T81					27.5	17	14.5	13.5	13.5
T86					32	19	14.5	13.5	13.0

- 3 to 20 percent lower depending upon the cladding thickness.
- 3.062 Modulus of elasticity in tension and compression for sheet in T3 Condition at room and elevated temperatures, Fig. 3.062.
- 3.063 Tangent modulus curves in compression for sheet in T3 Condition, Fig. 3.063.
- 3.064 Tangent modulus curves in compression for sheet in T81 and T86 Conditions at room and elevated temperatures, Fig. 3.064.

4. FABRICATION

In most respects this material performs in much the same manner as its core material, 2024. Exceptions are listed below.

- 4.01 Forming and Casting. The alloy has forming properties slightly superior to those of 2024.
- 4.03 Welding
- 4.031 Resistance welding of clad sheet in the heat treated conditions can be performed with special practices and over a narrow range of machine settings without reduction in corrosion resistance.
- 4.04 Heating and Heat Treating
- 4.041 Heat treating and reheat treating of clad material should be as fast and as short as necessary to obtain the specified properties. This requires a number of provisions during heat treating which are listed below (MLL-H-6088B(ASG)).
- 4.042 When solution treating clad material, the load and its distribution should permit heating within a minimum time. This includes the fact that a furnace charge should contain material of nearly equal thickness.
- 4.043 The soaking time should be as close as possible to the specified minimum time to prevent copper diffusion to the surface and decrease in corrosion resistance. Maximum soaking times for solution treating clad material, Table 4.043.

TABLE 4.043

Source	(12)	
	Thickness - in	Maximum Soaking Time - min
	Salt Bath	Air Furnace*
≤ 0.016	15**	25
0.017 to 0.020	20	30
0.021 to 0.032	25	35
0.033 to 0.063	30	40
0.064 to 0.090	35	45
0.091 to 0.125	40	50
0.126 to 0.250	45	60
0.251 to 0.500	55	70
0.501 to 1.000	70	100
1.001 to 1.500	100	130
1.501 to 2.000	115	160
2.001 to 2.500	130	190
2.501 to 3.000	160	220
3.001 to 3.500	175	250
3.501 to 4.000	190	280

* Total time in furnace when no load thermocouple is used should not exceed indicated times by more than 35 min if thickness is 0.102 in maximum and 60 min if thickness is greater than 0.102 in

** Times less than 20 min may not yield full solution treatment.

- 4.044 Spray quenching can be substituted for water quenching provided that the test for intergranular corrosion is passed
- 4.045 Resolution treating of clad aluminum alloys is limited to the following number of times: Thicknesses to 0.125 in maximum, once, thicknesses over 0.125 in, twice.
- 4.046 Regarding possible damage by improper heat treating and its detection, clad material differs from bare sheet in the following respects: In addition to the various damages possible in 2024, diffusion of copper should be tested by microscopic examination at 100 to 1000 X. To test for intergranular corrosion the cladding should be removed from both sides.

Al
4.5 Cu
1.5 Mg
0.6 Mn

CLAD 2024

4.05 Surface Treating

The cladding protects the core by galvanic action and Clad 2024, therefore, is subject to surface treating in much the same manner as pure aluminum (100).

4.052 Anodizing is the most popular type of surface treatment for additional corrosion protection.

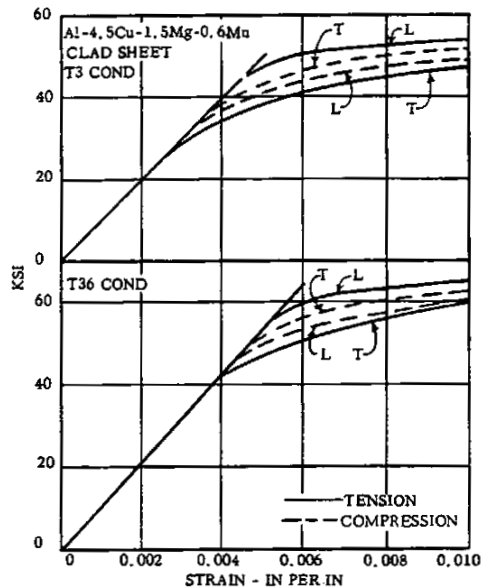


FIG. 3.021 STRESS STRAIN CURVES IN TENSION AND COMPRESSION FOR SHEET IN T3 AND T6 CONDITIONS (9)

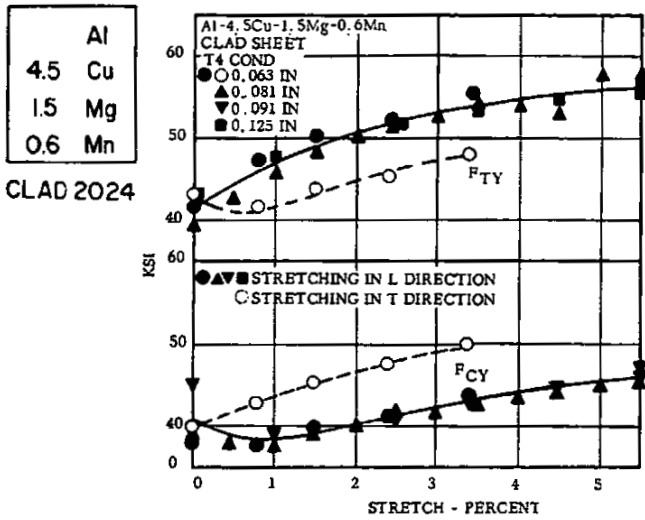


FIG. 3.022 EFFECT OF STRETCHING ON TENSILE AND COMPRESSIVE YIELD STRENGTHS OF SHEET IN T4 CONDITION

(9)

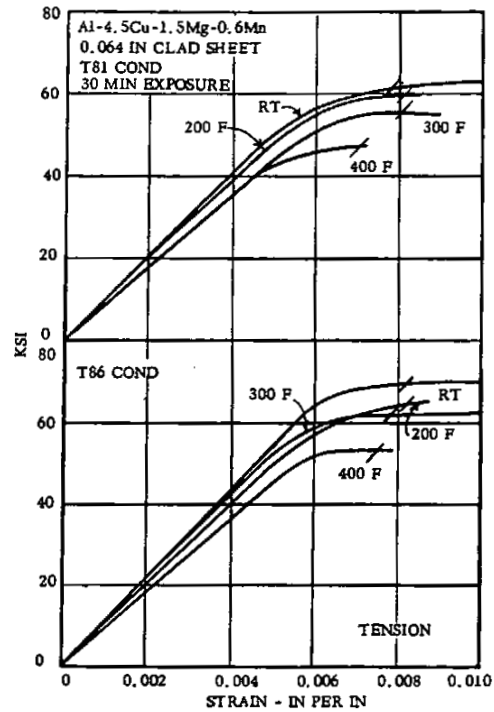


FIG. 3.0312 STRESS STRAIN CURVES FOR SHEET IN T81 AND T86 CONDITIONS AT ROOM AND ELEVATED TEMPERATURES

(5, p. 133-136, 145-148)

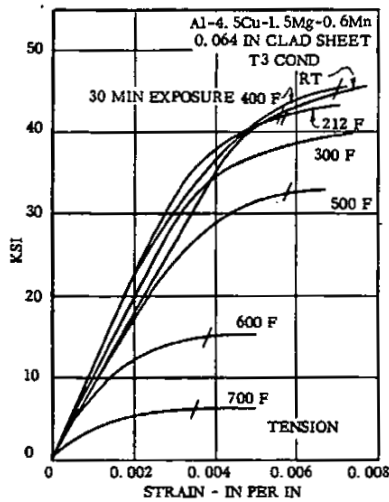


FIG. 3.0311 STRESS STRAIN CURVES FOR SHEET IN T3 CONDITION AT ROOM AND ELEVATED TEMPERATURES

(8, p. 1-7)

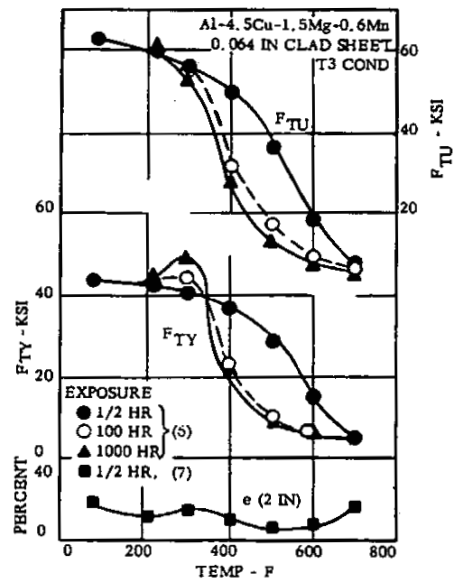


FIG. 3.0313 EFFECT OF EXPOSURE AND TEST TEMPERATURE ON TENSILE PROPERTIES OF SHEET IN T3 CONDITION

(c, p. 96)(7, p. 29)

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NONFERROUS ALLOYS

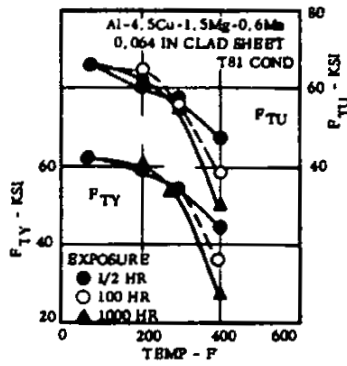


FIG. 3.0314 EFFECT OF EXPOSURE AND TEST TEMPERATURE ON TENSILE PROPERTIES OF SHEET IN T81 CONDITION (5, p. 42)

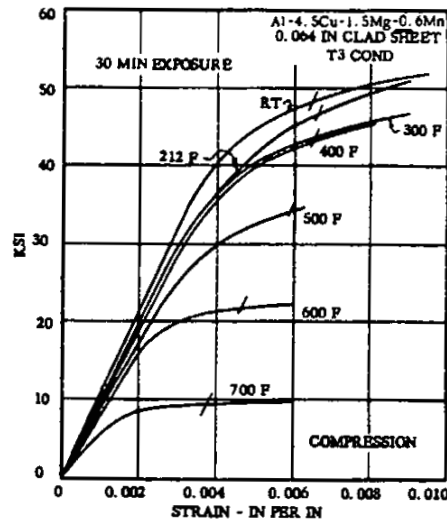


FIG. 3.0321 STRESS STRAIN CURVES IN COMPRESSION FOR SHEET IN T3 CONDITION AT ROOM AND ELEVATED TEMPERATURES (8, p. 8-14)

Al
4.5 Cu
1.5 Mg
0.6 Mn

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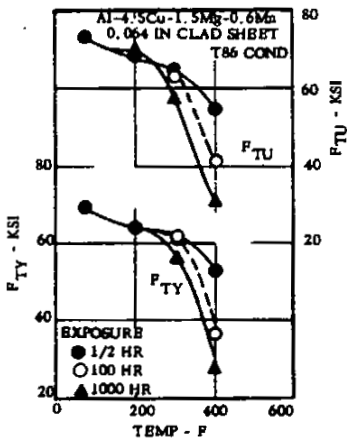


FIG. 3.0315 EFFECT OF EXPOSURE AND TEST TEMPERATURE ON TENSILE PROPERTIES OF SHEET IN T86 CONDITION (5, p. 44)

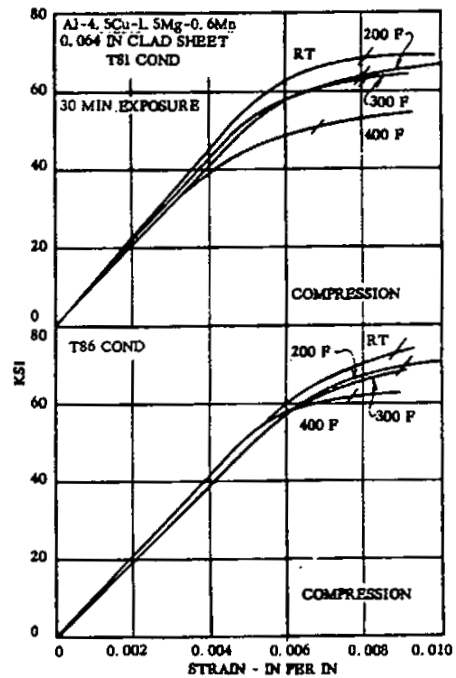


FIG. 3.0322 STRESS STRAIN CURVES IN COMPRESSION FOR SHEET IN T81 AND T86 CONDITIONS AT ROOM AND ELEVATED TEMPERATURES (5, p. 137-140, 149-152)

Al
4.5 Cu
1.5 Mg
0.6 Mn
CLAD 2024

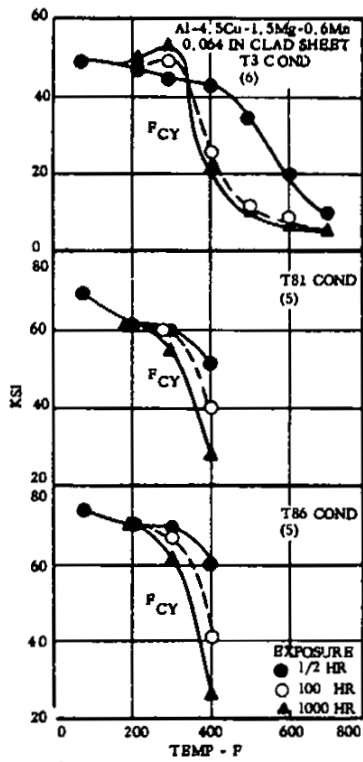


FIG. 3.0323 EFFECT OF EXPOSURE AND TEST TEMPERATURE ON COMPRESSIVE YIELD STRENGTH OF SHEET IN T3, T81 AND T86 CONDITIONS (S, p. 42, 44)(6, p. 97)

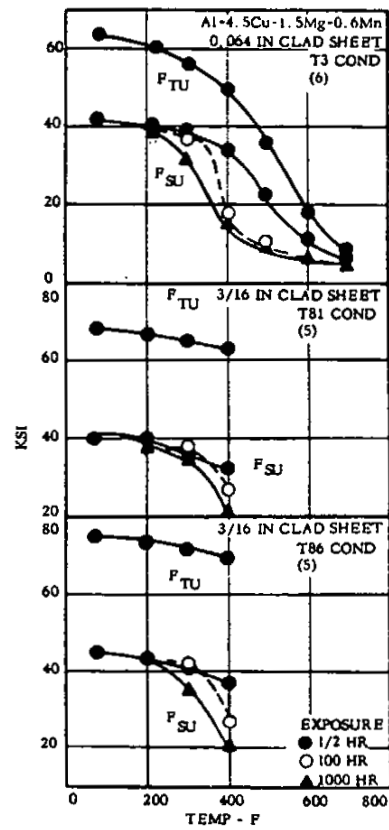


FIG. 3.0324 EFFECT OF EXPOSURE AND TEST TEMPERATURE ON SHEAR STRENGTH OF SHEET IN T3, T81 AND T86 CONDITIONS (S, p. 42, 44)(6, p. 96, 99)

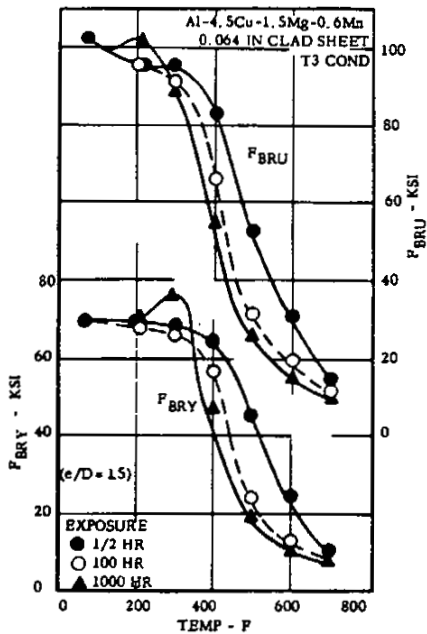


FIG. 3.0325 EFFECT OF EXPOSURE AND TEST TEMPERATURE ON BEARING PROPERTIES OF SHEET IN T3 CONDITION (6, p. 98)

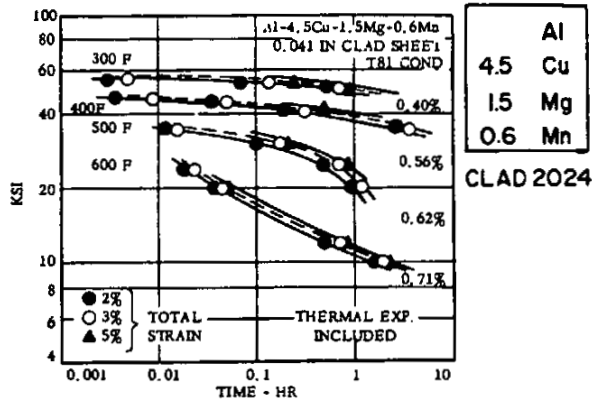


FIG. 3.041 SHORT TIME TOTAL STRAIN CURVES FOR SHEET IN T81 CONDITION AT 300 TO 600 F (11, p. 33, 34)

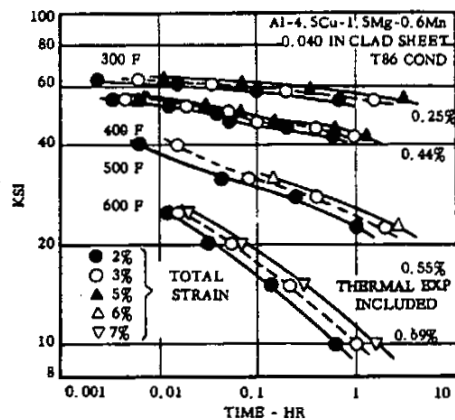


FIG. 3.042 SHORT TIME TOTAL STRAIN CURVES FOR SHEET IN T86 CONDITION AT 300 TO 600 F (10, p. 38-41)

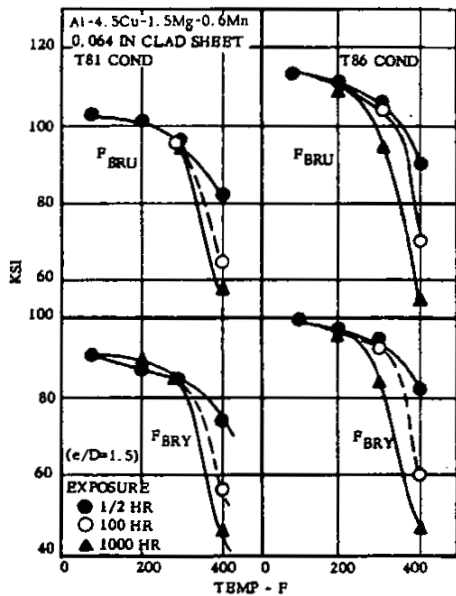


FIG. 3.0326 EFFECT OF EXPOSURE AND TEST TEMPERATURE ON BEARING PROPERTIES OF SHEET IN T81 AND T86 CONDITIONS (5, p. 98, 102)

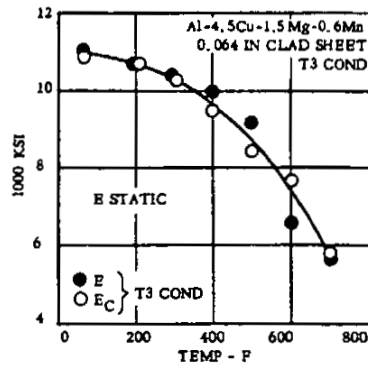


FIG. 3.062 MODULUS OF ELASTICITY IN TENSION AND COMPRESSION FOR SHEET IN T3 CONDITION AT ROOM AND ELEVATED TEMPERATURES (6, p. 96, 97)

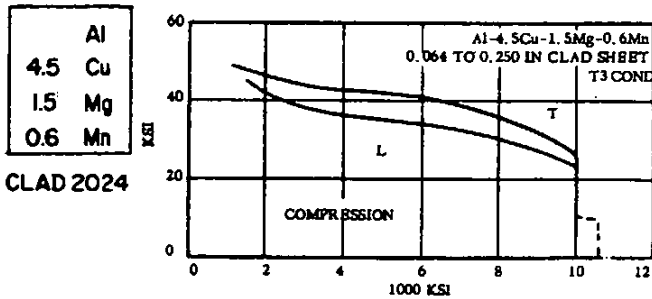


FIG. 3.063 TANGENT MODULUS CURVES IN COMPRESSION FOR SHEET IN T3 CONDITION (4, p.84)

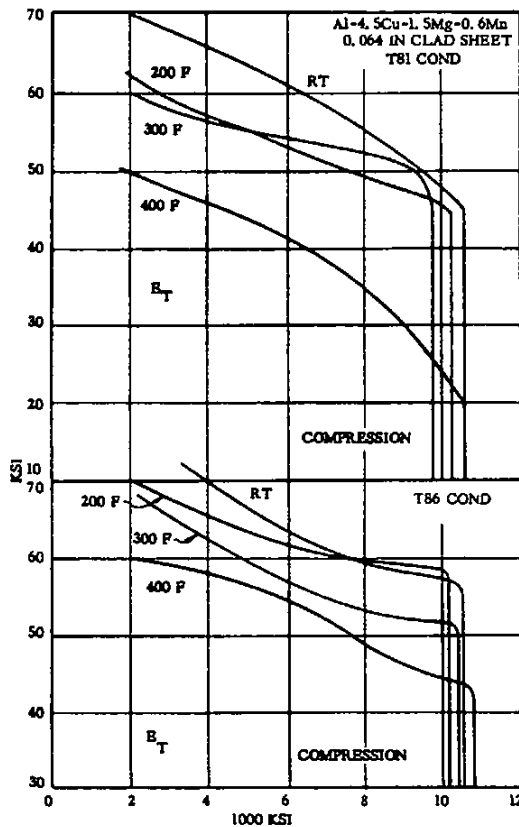


FIG. 3.064 TANGENT MODULUS CURVES IN COMPRESSION FOR SHEET IN T81 AND T86 CONDITIONS AT ROOM AND ELEVATED TEMPERATURES (5, p.189-196)

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