Table of Total Emissivity

These tables are presented for use as a guide when making infrared temperature measurements with the OMEGASCOPE® or other infrared pyrometers. The total emissivity (ε) for Metals, Non-metals and Common Building Materials are given.

Since the emissivity of a material will vary as a function of temperature and surface finish, the values in these tables should be used only as a guide for relative or delta measurements.
The exact emissivity of a material should be determined when absolute measurements are required.

METALS

Material	Temp °F (°C)	ε Emissivity
Alloys		
20-Ni, 24-CR, 55-FE, Oxid.	392 (200)	.90
20-Ni, 24-CR, 55-FE, Oxid.	932 (500)	.97
60-Ni , 12-CR, 28-FE, Oxid.	518 (270)	.89
60-Ni , 12-CR, 28-FE, Oxid.	1040 (560)	.82
80-Ni, 20-CR, Oxidized	212 (100)	.87
80-Ni, 20-CR, Oxidized	1112 (600)	.87
80-Ni, 20-CR, Oxidized	2372 (1300)	.89
Aluminum		
Unoxidized	77 (25)	.02
Unoxidized	212 (100)	.03
Unoxidized	932 (500)	.06
Oxidized	390 (199)	.11
Oxidized	1110 (599)	.19
Oxidized at 599°C (1110°F)	390 (199)	.11
Oxidized at 599°C (1110°F)	1110 (599)	.19
Heavily Oxidized	200 (93)	.20
Heavily Oxidized	940 (504)	.31
Highly Polished	212 (100)	.09
Roughly Polished	212 (100)	.18
Commercial Sheet	212 (100)	.09
Highly Polished Plate	440 (227)	.04
Highly Polished Plate	1070 (577)	.06
Bright Rolled Plate	338 (170)	.04
Bright Rolled Plate	932 (500)	.05
Alloy A3003, Oxidized	600 (316)	.40
Alloy A3003, Oxidized	900 (482)	.40
Alloy 1100-0	200-800 (93-427)	.05
Alloy 24ST	75 (24)	.09
Alloy 24ST, Polished	75 (24)	.09
Alloy 75ST	75 (24)	.11
Alloy 75ST, Polished	75 (24)	.08
Bismuth, Bright	176 (80)	.34
Bismuth, Unoxidized	77 (25)	.05
Bismuth, Unoxidized	212 (100)	.06
Brass		
73% Cu, 27% Zn, Polished	476 (247)	.03
73% Cu, 27% Zn, Polished	674 (357)	.03
62% Cu, 37% Zn, Polished	494 (257)	.03
62% Cu, 37% Zn, Polished	710 (377)	.04
83% Cu, 17% Zn, Polished	530 (277)	.03
Matte	68 (20)	.07
Burnished to Brown Color	68 (20)	.40
Cu-Zn, Brass Oxidized	392 (200)	.61
Cu-Zn, Brass Oxidized	752 (400)	.60
Cu-Zn, Brass Oxidized	1112 (600)	.61
Unoxidized	77 (25)	.04
Unoxidized	212 (100)	.04
Cadmium	77 (25)	.02
Carbon		
Lampblack	77 (25)	.95
Unoxidized	77 (25)	.81
Unoxidized	212 (100)	.81
Unoxidized	932 (500)	.79
Candle Soot	250 (121)	.95
Filament	500 (260)	.95
Graphitized	212 (100)	.76
Graphitized	572 (300)	.75
Graphitized	932 (500)	.71
Chromium	100 (38)	.08
Chromium	1000 (538)	.26
Chromium, Polished	302 (150)	.06
Cobalt, Unoxidized	932 (500)	.13
Cobalt, Unoxidized	1832 (1000)	.23
Columbium, Unoxidized	1500 (816)	.19
Columbium, Unoxidized	2000 (1093)	.24
Copper		
Cuprous Oxide	100 (38)	.87
Cuprous Oxide	500 (260)	.83
Cuprous Oxide	1000 (538)	.77
Black, Oxidized	100 (38)	.78
Etched	100 (38)	.09
Matte	100 (38)	.22
Roughly Polished	100 (38)	.07
Polished	100 (38)	.03
Highly Polished	100 (38)	.02
Rolled	100 (38)	.64
Rough	100 (38)	.74
Molten	1000 (538)	.15
Molten	1970 (1077)	.16
Molten	2230 (1221)	.13
Nickel Plated	100-500 (38-260)	.37
Dow Metal	0.4-600 (–18-316)	.15
Gold		
Enamel	212 (100)	.37
Plate (.0001)		
Plate on .0005 Silver	200-750 (93-399)	.11-.14
Plate on .0005 Nickel	200-750 (93-399)	.07-.09
Polished	100-500 (38-260)	.02
Polished	1000-2000 (538-1093)	.03
Haynes Alloy C,		
Oxidized	600-2000 (316-1093)	.90-.96
Haynes Alloy 25,		
Oxidized	600-2000 (316-1093)	.86-.89
Haynes Alloy X,		
Oxidized	600-2000 (316-1093)	.85-.88
Inconel Sheet	1000 (538)	.28
Inconel Sheet	1200 (649)	.42
Inconel Sheet	1400 (760)	.58
Inconel X, Polished	75 (24)	.19
Inconel B, Polished	75 (24)	.21
Iron		
Oxidized	212 (100)	.74
Oxidized	930 (499)	.84
Oxidized	2190 (1199)	.89
Unoxidized	212 (100)	.05
Red Rust	77 (25)	.70
Rusted	77 (25)	.65
Liquid	2760-3220 (1516-1771)	.42-.45
Cast Iron		
Oxidized	390 (199)	.64
Oxidized	1110 (599)	.78
Unoxidized	212 (100)	.21
Strong Oxidation	40 (104)	.95
Strong Oxidation	482 (250)	.95
Liquid	2795 (1535)	.29
Wrought Iron		
Dull	77 (25)	.94
Dull	660 (349)	.94
Smooth	100 (38)	.35
Polished	100 (38)	.28
Lead		
Polished	100-500 (38-260)	.06-.08
Rough	100 (38)	.43
Oxidized	100 (38)	.43
Oxidized at 1100°F	100 (38)	.63
Gray Oxidized	100 (38)	.28
Magnesium	100-500 (38-260)	.07-.13
Magnesium Oxide	1880-3140 (1027-1727)	.16-.20
Mercury	32 (0)	.09
Mercury	77 (25)	.10
Mercury	100 (38)	.10
	212 (100)	.12
Molybdenum	100 (38)	.06
Molybdenum	500 (260)	.08
Molybdenum	1000 (538)	.11
Molybdenum	2000 (1093)	.18
" Oxidized at 1000°F	600 (316)	.80
" Oxidized at 1000°F	700 (371)	.84
" Oxidized at 1000°F	800 (427)	.84
" Oxidized at 1000°F	900 (482)	.83
" Oxidized at 1000°F	1000 (538)	.82
Monel, Ni-Cu	392 (200)	.41
Monel, Ni-Cu	752 (400)	.44
Monel, Ni-Cu	1112 (600)	.46
Monel, Ni-Cu Oxidized	68 (20)	.43
Monel, Ni-Cu Oxid. at 1110°F	1110 (599)	.46
Nickel		
Polished	100 (38)	.05
Oxidized	100-500 (38-260)	.31-.46
Unoxidized	77 (25)	.05
Unoxidized	212 (100)	.06
Unoxidized	932 (500)	.12
Unoxidized	1832 (1000)	.19
Electrolytic	100 (38)	.04
Electrolytic	500 (260)	.06
Electrolytic	1000 (538)	.10
Electrolytic	2000 (1093)	.16
Nickel Oxide	1000-2000 (538-1093)	.59-.86
Palladium Plate (.00005 on .0005 silver)	200-750 (93-399)	.16-.17
Platinum	100 (38)	.05
Platinum	500 (260)	.05
Platinum	1000 (538)	.10
Platinum, Black	100 (38)	.93
Platinum, Black	500 (260)	.96
Platinum, Black	2000 (1093)	.97
" Oxidized at 1100°F	500 (260)	.07
"	1000 (538)	.11
Rhodium Flash (0.0002 on 0.0005 Ni)	200-700 (93-371)	.10-.18
Silver		
Plate (0.0005 on Ni)	200-700 (93-371)	.06-.07
Polished	100 (38)	.01
Polished	500 (260)	.02
Polished	1000 (538)	.03
Polished	2000 (1093)	.03
Steel		
Cold Rolled	200 (93)	.75-.85
Ground Sheet	1720-2010 (938-1099)	.55-.61
Polished Sheet	100 (38)	.07
Polished Sheet	500 (260)	.10
Polished Sheet	1000 (538)	.14
Mild Steel, Polished	75 (24)	.10
Mild Steel, Smooth	75 (24)	.12
Mild Steel, Liquid	2910-3270 (1599-1793)	.28
Steel, Unoxidized	212 (100)	.08
Steel, Oxidized	77 (25)	.80
Steel Alloys		
Type 301, Polished	75 (24)	.27
Type 301, Polished	450 (232)	.57
Type 301, Polished	1740 (949)	.55
Type 303, Oxidized	600-2000 (316-1093)	.74-.87
Type 310, Rolled	1500-2100 (816-1149)	.56-.81
Type 316, Polished	75 (24)	.28
Type 316, Polished	450 (232)	.57
Type 316, Polished	1740 (949)	.66
Type 321	200-800 (93-427)	.27-.32
Type 321 Polished	300-1500 (149-815)	.18-.49
Type 321 w/BK Oxide	200-800 (93-427)	.66-.76
Type 347, Oxidized	600-2000 (316-1093)	.87-.91
Type 350	200-800 (93-427)	.18-.27
Type 350 Polished	300-1800 (149-982)	.11-.35
Type 446, Polished	300-1500 (149-815)	.15-.37
Type 17-7 PH	200-600 (93-316)	.44-.51
Type 17-7 PH Polished	300-1500 (149-815)	.09-.16
Type C1020, Oxidized	600-2000 (316-1093)	.87-.91
Type PH-15-7 MO	300-1200 (149-649)	.07-.19
Stellite, Polished	68 (20)	.18
Tantalum, Unoxidized	1340 (727)	.14
"	2000 (1093)	.19
"	3600 (1982)	.26
"	5306 (2930)	.30
Tin, Unoxidized	77 (25)	.04
"	212 (100)	.05
Tinned Iron, Bright	76 (24)	.05
	212 (100)	.08

Table of Total Emissivity Cont'd

METALS

Material	Temp ºF (ºC)	ε Emmissivity
Titanium		
Alloy C110M, Polished	300-1200 (149-649)	.08-.19
" Oxidized at 538°C (1000°F)	200-800 (93-427)	.51-.61
Alloy Ti-95A, Oxid. at 538°C (1000°F)	200-800 (93-427)	.35-.48
Anodized onto SS	200-600 (93-316)	.96-.82

Material	Temp ºF (ºC)	ε Emmissivity
Tungsten		
Unoxidized	77 (25)	.02
Unoxidized	212 (100)	.03
Unoxidized	932 (500)	.07
Unoxidized	1832 (1000)	.15
Unoxidized	2732 (1500)	.23
Unoxidized	3632 (2000)	.28
Filament (Aged)	100 (38)	.03
Filament (Aged)	1000 (538)	.11
Filament (Aged)	5000 (2760)	.35

Material	Temp ºF (ºC)	ε Emmissivity
Uranium Oxide	1880 (1027)	.79
Zinc		
Bright, Galvanized	100 (38)	.23
Commercial 99.1%	500 (260)	.05
Galvanized	100 (38)	.28
Oxidized	500-1000 (260-538)	.11
Polished	100 (38)	.02
Polished	500 (260)	.03
Polished	1000 (538)	.04
Polished	2000 (1093)	.06

NON-METALS

Material	Temp ºF (ºC)	ε Emmissivity
Adobe	68 (20)	.90
Asbestos		
Board	100 (38)	.96
Cement	32-392 (0-200)	.96
Cement, Red	2500 (1371)	.67
Cement, White	2500 (1371)	.65
Cloth	199 (93)	.90
Paper	100-700 (38-371)	.93
Slate	68 (20)	.97
Asphalt, pavement	100 (38)	.93
Asphalt, tar paper	68 (20)	.93
Basalt	68 (20)	.72
Brick		
Red, rough	70 (21)	.93
Gault Cream	2500-5000 (1371-2760)	.26-.30
Fire Clay	2500 (1371)	.75
Light Buff	1000 (538)	.80
Lime Clay	2500 (1371)	.43
Fire Brick	1832 (1000)	.75-.80
Magnesite, Refractory	1832 (1000)	.38
Gray Brick	2012 (1100)	.75
Silica, Glazed	2000 (1093)	.88
Silica, Unglazed	2000 (1093)	.80
Sandlime	2500-5000 (1371-2760)	.59-.63
Carborundum	1850 (1010)	.92
Ceramic		
Alumina on Inconel	800-2000 (427-1093)	.69-.45
Earthenware, Glazed	70 (21)	.90
Earthenware, Matte	70 (21)	.93
Greens No. 5210-2C	200-750 (93-399)	.89-.82
Coating No. C20A	200-750 (93-399)	.73-.67
Porcelain	72 (22)	.92
White Al2O3	200 (93)	.90
Zirconia on Inconel	800-2000 (427-1093)	.62-.45
Clay	68 (20)	.39
" Fired	158 (70)	.91
" Shale	68 (20)	.69
" Tiles, Light Red	2500-5000 (1371-2760)	.32-.34
" Tiles, Red	2500-5000 (1371-2760)	.40-.51
" Tiles, Dark Purple	2500-5000 (1371-2760)	.78
Concrete		
Rough	32-2000 (0-1093)	.94
Tiles, Natural	2500-5000 (1371-2760)	.63-.62
" Brown	2500-5000 (1371-2760)	.87-.83
" Black	2500-5000 (1371-2760)	.94-.91
Cotton Cloth	68 (20)	.77
Dolomite Lime	68 (20)	.41
Emery Corundum	176 (80)	.86
Glass		
Convex D	212 (100)	.80
Convex D	600 (316)	.80
Convex D	932 (500)	.76
Nonex	212 (100)	.82
Nonex	600 (316)	.82
Nonex	932 (500)	.78
Smooth	32-200 (0-93)	.92-.94

Material	Temp ºF (ºC)	ε Emmissivity
Granite	70 (21)	.45
Gravel	100 (38)	.28
Ice, Smooth	32 (0)	.97
Ice, Rough	32 (0)	.98
Lacquer		
Black	200 (93)	.96
Blue, on Al Foil	100 (38)	.78
Clear, on Al Foil (2 coats)	200 (93)	.08 (.09)
Clear, on Bright Cu	200 (93)	.66
Clear, on Tarnished Cu	200 (93)	.64
Red, on Al Foil (2 coats)	100 (38)	.61 (.74)
White	200 (93)	.95
White, on Al Foil (2 coats)	100 (38)	.69 (.88)
Yellow, on Al Foil (2 coats)	100 (38)	.57 (.79)
Lime Mortar	100-500 (38-260)	.90-.92
Limestone	100 (38)	.95
Marble, White	100 (38)	.95
" Smooth, White	100 (38)	.56
" Polished Gray	100 (38)	.75
Mica	100 (38)	.75
Oil on Nickel		
0.001 Film	72 (22)	.27
0.002 "	72 (22)	.46
0.005 "	72 (22)	.72
Thick "	72 (22)	.82
Oil, Linseed		
On Al Foil, uncoated	250 (121)	.09
On Al Foil, 1 coat	250 (121)	.56
On Al Foil, 2 coats	250 (121)	.51
On Polished Iron, .001 Film	100 (38)	.22
On Polished Iron, .002 Film	100 (38)	.45
On Polished Iron, .004 Film	100 (38)	.65
On Polished Iron, Thick Film	100 (38)	.83
Paints		
Blue, Cu2O3	75 (24)	.94
Black, CuO	75 (24)	.96
Green, Cu2O3	75 (24)	.92
Red, Fe2O3	75 (24)	.91
White, Al2O3	75 (24)	.94
White, Y2O3	75 (24)	.90
White, ZnO	75 (24)	.95
White, MgCO3	75 (24)	.91
White, ZrO2	75 (24)	.95
White, ThO2	75 (24)	.90
White, MgO	75 (24)	.91
White, PbCO3	75 (24)	.93
Yellow, PbO	75 (24)	.90
Yellow, PbCrO4	75 (24)	.93
Paints, Aluminium	100 (38)	.27-.67
10% Al	100 (38)	.52
26% Al	100 (38)	.30
Dow XP-310	200 (93)	.22
Paints, Bronze	Low	.34-.80
Gum Varnish (2 coats)	70 (21)	.53
Gum Varnish (3 coats)	70 (21)	.50
Cellulose Binder (2 coats)	70 (21)	.34

Material	Temp ºF (ºC)	ε Emmissivity
Paints, Oil		
All colors	200 (93)	.92-.96
Black	200 (93)	.92
Black Gloss	70 (21)	.90
Camouflage Green	125 (52)	.85
Flat Black	80 (27)	.88
Flat White	80 (27)	.91
Gray-Green	70 (21)	.95
Green	200 (93)	.95
Lamp Black	209 (98)	.96
Red	200 (93)	.95
White	200 (93)	.94
Quartz, Rough, Fused	70 (21)	.93
Glass, 1.98 mm	540 (282)	.90
Glass, 1.98 mm	1540 (838)	.41
Glass, 6.88 mm	540 (282)	.93
Glass, 6.88 mm	1540 (838)	.47
Opaque	570 (299)	.92
Opaque	1540 (838)	.68
Red Lead	212 (100)	.93
Rubber, Hard	74 (23)	.94
Rubber, Soft, Gray	76 (24)	.86
Sand	68 (20)	.76
Sandstone	100 (38)	.67
Sandstone, Red	100 (38)	.60-.83
Sawdust	68 (20)	.75
Shale	68 (20)	.69
Silica,Glazed	1832 (1000)	.85
Silica, Unglazed	2012 (1100)	.75
Silicon Carbide	300-1200 (149-649)	.83-.96
Silk Cloth	68 (20)	.78
Slate	100 (38)	.67-.80
Snow, Fine Particles	20 (–7)	.82
Snow, Granular	18 (–8)	.89
Soil		
Surface	100 (38)	.38
Black Loam	68 (20)	.66
Plowed Field	68 (20)	.38
Soot		
Acetylene	75 (24)	.97
Camphor	75 (24)	.94
Candle	250 (121)	.95
Coal	68 (20)	.95
Stonework	100 (38)	.93
Water	100 (38)	.67
Waterglass	68 (20)	.96
Wood	Low	.80-.90
Beech P!aned	158 (70)	.94
Oak, Planed	100 (38)	.91
Spruce, Sanded	100 (38)	.89