# Aluminum, 2024, wrought, O



## General information

### Designation

2024

| | |
|---|---|
| Condition | O (Annealed) |
| UNS number | A92024 |
| EN name | EN AW-2024 (EN AW-Al Cu4Mg1) |
| EN number | 3.1355 |

### Typical uses

Screw machine products, aircraft applications, weapons manufacture, light beams, sports equipment.

## Composition overview

### Compositional summary

Al91-95 / Cu3.8-4.9 / Mg1.2-1.8 / Mn0.3-0.9 (impurities: Fe<0.5, Si<0.5, Zn<0.25, Ti<0.15, Cr<0.1, Other<0.15)

| | |
|---|---|
| Material family | Metal (non-ferrous) |
| Base material | Al (Aluminum) |

## Composition detail (metals, ceramics and glasses)

| | | | | | |
|---|---|---|---|---|---|
| Al (aluminum) | * | 90.8 | - | 94.7 | % |
| Cr (chromium) | | 0 | - | 0.1 | % |
| Cu (copper) | | 3.8 | - | 4.9 | % |
| Fe (iron) | | 0 | - | 0.5 | % |
| Mg (magnesium) | | 1.2 | - | 1.8 | % |
| Mn (manganese) | | 0.3 | - | 0.9 | % |
| Si (silicon) | | 0 | - | 0.5 | % |
| Ti (titanium) | | 0 | - | 0.15 | % |
| Zn (zinc) | | 0 | - | 0.25 | % |
| Other | | 0 | - | 0.15 | % |

## Price

| | | | | | |
|---|---|---|---|---|---|
| Price | * | 1.06 | - | 1.17 | USD/lb |

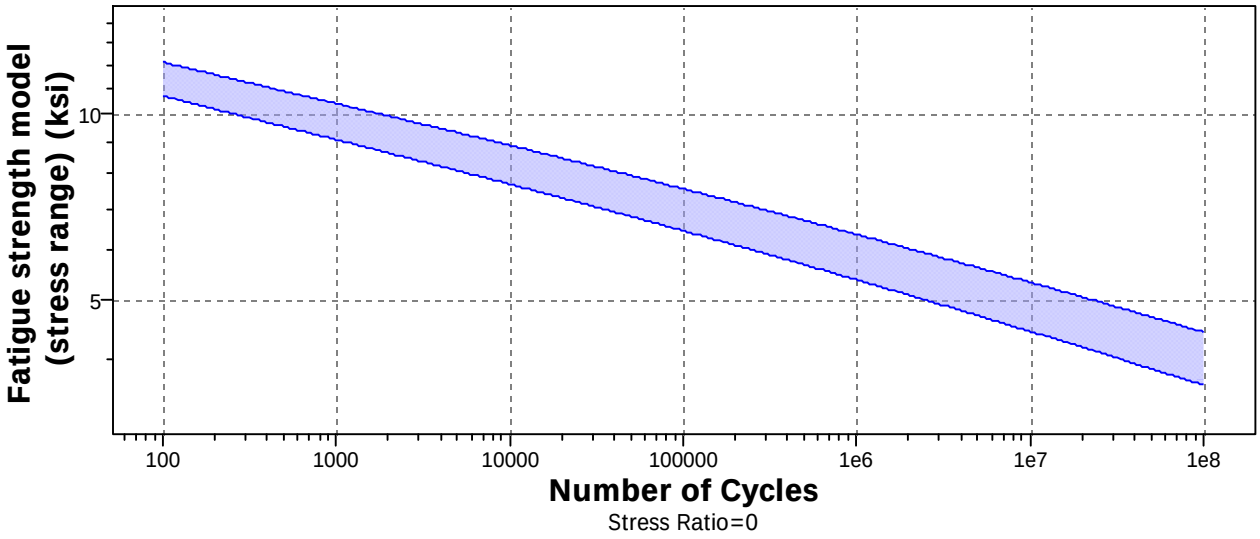
## Physical properties

| | | | | | |
|---|---|---|---|---|---|
| Density | | 0.099 | - | 0.101 | lb/in^3 |

## Mechanical properties

| | | | | | |
|---|---|---|---|---|---|
| Young's modulus | | 10.6 | - | 11.2 | 10^6 psi |
| Yield strength (elastic limit) | | 10.3 | - | 11.5 | ksi |
| Tensile strength | | 25.5 | - | 28.1 | ksi |
| Elongation | | 18.5 | - | 21.5 | % strain |
| Compressive strength | * | 10.3 | - | 11.5 | ksi |
| Flexural modulus | * | 10.6 | - | 11.2 | 10^6 psi |
| Flexural strength (modulus of rupture) | | 10.3 | - | 11.5 | ksi |
| Shear modulus | | 3.77 | - | 4.06 | 10^6 psi |
| Bulk modulus | | 9.86 | - | 10.9 | 10^6 psi |
| Poisson's ratio | | 0.325 | - | 0.335 | |
| Shape factor | | 41 | | | |
| Hardness - Vickers | | 52.3 | - | 57.8 | HV |
| Fatigue strength at 10^7 cycles | * | 5.67 | - | 6.24 | ksi |
| Fatigue strength model (stress range) | * | 4.44 | - | 5.33 | ksi |

Parameters: Stress Ratio = 0, Number of Cycles = 1e7cycles




| | | | | | |
|---|---|---|---|---|---|
| Mechanical loss coefficient (tan delta) | * | 1e-4 | - | 0.002 | |

## Impact & fracture properties

| | | | | | |
|---|---|---|---|---|---|
| Fracture toughness | | 33.7 | - | 35.5 | ksi.in^0.5 |

## Thermal properties

| | | | | | |
|---|---|---|---|---|---|
| Melting point | | 932 | - | 1.18e3 | °F |
| Maximum service temperature | | 338 | - | 392 | °F |
| Minimum service temperature | | -459 | | | °F |
| Thermal conductivity | | 109 | - | 114 | BTU.ft/hr.ft^2.°F |
| Specific heat capacity | | 0.205 | - | 0.213 | BTU/lb.°F |
| Thermal expansion coefficient | | 12.5 | - | 13.2 | µstrain/°F |
| Latent heat of fusion | | 165 | - | 169 | BTU/lb |

## Electrical properties

| | | | | | |
|---|---|---|---|---|---|
| Electrical resistivity | | 3.6 | - | 3.8 | µohm.cm |
| Galvanic potential | * | -0.78 | - | -0.7 | V |

## Optical properties

| | |
|---|---|
| Transparency | Opaque |

## Magnetic properties

| | |
|---|---|
| Magnetic type | Non-magnetic |

## Bio-data

| | |
|---|---|
| RoHS (EU) compliant grades? | ✓ |
| Food contact | Yes |

## Processing properties

| | |
|---|---|
| Metal casting | Unsuitable |
| Metal cold forming | Acceptable |
| Metal hot forming | Limited use |
| Metal press forming | Acceptable |
| Metal deep drawing | Limited use |

## Durability

| | |
|---|---|
| Water (fresh) | Excellent |
| Water (salt) | Acceptable |
| Weak acids | Excellent |
| Strong acids | Excellent |
| Weak alkalis | Acceptable |
| Strong alkalis | Unacceptable |
| Organic solvents | Excellent |
| Oxidation at 500C | Unacceptable |
| UV radiation (sunlight) | Excellent |
| Flammability | Non-flammable |

## Primary production energy, CO2 and water

| | | | | |
|---|---|---|---|---|
| Embodied energy, primary production | * 7.95e4 | - | 8.77e4 | BTU/lb |
| CO2 footprint, primary production | * 12.4 | - | 13.7 | lb/lb |
| NOx creation | * 0.0748 | - | 0.0827 | lb/lb |
| SOx creation | * 0.128 | - | 0.141 | lb/lb |
| Water usage | * 3.04e4 | - | 3.38e4 | in^3/lb |

## Processing energy, CO2 footprint & water

| | | | | |
|---|---|---|---|---|
| Rough rolling, forging energy | * 859 | - | 949 | BTU/lb |
| Rough rolling, forging CO2 | * 0.15 | - | 0.166 | lb/lb |
| Rough rolling, forging water | * 66.7 | - | 99.9 | in^3/lb |
| Extrusion, foil rolling energy | * 1.59e3 | - | 1.76e3 | BTU/lb |
| Extrusion, foil rolling CO2 | * 0.278 | - | 0.308 | lb/lb |
| Extrusion, foil rolling water | * 86.9 | - | 130 | in^3/lb |
| Wire drawing energy | * 5.64e3 | - | 6.24e3 | BTU/lb |
| Wire drawing CO2 | * 0.985 | - | 1.09 | lb/lb |
| Wire drawing water | * 137 | - | 205 | in^3/lb |
| Metal powder forming energy | * 8.7e3 | - | 9.62e3 | BTU/lb |
| Metal powder forming CO2 | * 1.62 | - | 1.79 | lb/lb |
| Metal powder forming water | * 611 | - | 916 | in^3/lb |
| Vaporization energy | * 6.66e6 | - | 7.37e6 | BTU/lb |
| Vaporization CO2 | * 1.16e3 | - | 1.28e3 | lb/lb |
| Vaporization water | * 1.79e5 | - | 2.68e5 | in^3/lb |
| Coarse machining energy (per unit wt removed) | * 315 | - | 348 | BTU/lb |
| Coarse machining CO2 (per unit wt removed) | * 0.0549 | - | 0.0607 | lb/lb |
| Fine machining energy (per unit wt removed) | * 1.31e3 | - | 1.45e3 | BTU/lb |
| Fine machining CO2 (per unit wt removed) | * 0.228 | - | 0.252 | lb/lb |
| Grinding energy (per unit wt removed) | * 2.41e3 | - | 2.67e3 | BTU/lb |
| Grinding CO2 (per unit wt removed) | * 0.421 | - | 0.465 | lb/lb |
| Non-conventional machining energy (per unit wt removed) | * 6.66e4 | - | 7.37e4 | BTU/lb |
| Non-conventional machining CO2 (per unit wt removed) | * 11.6 | - | 12.8 | lb/lb |

## Recycling and end of life

| | | | | |
|---|---|---|---|---|
| Recycle | ✓ | | | |
| Embodied energy, recycling | * 1.36e4 | - | 1.5e4 | BTU/lb |
| CO2 footprint, recycling | * 2.49 | - | 2.75 | lb/lb |
| Recycle fraction in current supply | 40.5 | - | 44.7 | % |
| Downcycle | ✓ | | | |
| Combust for energy recovery | ✗ | | | |
| Landfill | ✓ | | | |
| Biodegrade | ✗ | | | |

**Possible substitutes for principal component**

Copper can replace aluminum in electrical applications; magnesium, titanium, and steel can substitute for aluminum in structural and ground transportation uses. Composites, wood, and steel can substitute for aluminum in construction. Glass, plastics, paper, and steel can substitute for aluminum in packaging.

## Geo-economic data for principal component

| | | | | |
|---|---|---|---|---|
| Principal component | Aluminum | | | |
| Typical exploited ore grade | 30.4 | - | 33.6 | % |
| Minimum economic ore grade | 25 | - | 39 | % |
| Abundance in Earth's crust | 8.2e4 | | | ppm |
| Abundance in seawater | 5e-4 | - | 0.005 | ppm |
| Annual world production | 4.34e7 | | | ton/yr |
| Reserves | 4.67e10 | - | 5.16e10 | l. ton |

### Main mining areas (metric tonnes per year)

Argentina, 460e3
Australia, 1.75e6
Bahrain, 900e3
Brazil, 1.33e6
Canada, 2.9e6
China, 21.5e6
Germany, 400e3
Iceland, 825e3
India, 1.7e6
Mozambique, 560e3
Norway, 1.2e6
Qatar, 600e3
Russia, 3.95e6
South Africa, 820e3
United Arab Emirates, 1.8e6
United States, 1.95e6
Other countries, 4.65e6

## Eco-indicators for principal component

| | | |
|---|---|---|
| Eco-indicator 95 | 354 | millipoints/lb |
| Eco-indicator 99 | 322 | millipoints/lb |

## Notes

### Other notes

Prices of Aluminum alloys fluctuate greatly and are dependent on batch size, unit size, forming methods, etc.

### Keywords

AVIONAL, Alcan Alluminio SpA (ITALY); AVIONAL, Aluminium Walzwerke Singen GmbH (GERMANY); ALUDUR 570, German manufacture (Germany); LENNEDUR, Westfalische Leichmetallwerke GmbH (GERMANY); CHITONAL-24, Alcan Alluminio SpA (ITALY); CHITONAL-24, Alumix S.P.A. (ITALY); AK 24, Otto Fuchs Metallwerke (GERMANY); AK 25, Otto Fuchs Metallwerke (GERMANY); ALCAN GB-24S, British Alcan Aluminium plc (UK); AK 15, Otto Fuchs Metallwerke (GERMANY);

### Standards with similar compositions

The following information is taken from ASM AlloyFinder 3 - see link to References table for further information.
CSA HA.4 0.2024 (ON Canada)
CSA HA.4 2024Alclad (ON Canada)
CSA HA.5 0.2024 (ON Canada)
CSA HA.6 0.2024 (ON Canada)
CSA HA.7 0.2024 (ON Canada)
ISO: Al-Cu4Mg1
UK (BS): 2L97
UK (BS Pre-1980): n/a
USA (UNS): A92024
Germany (W.-Nr): 3.1355
Germany (DIN): AlCuMg2
France: A-U4G1
Italy (UNI): 9002/4

## Links

ProcessUniverse

Producers

Reference

Shape