

2024 T3 Aluminum Alloy – Technical Material Specification

1.0 Material Overview & Common Uses

2024 T3 aluminum is a high-strength, heat-treatable aluminum-copper alloy (Al-Cu-Mg) known for its excellent strength-to-weight ratio and good machinability. The T3 temper indicates solution heat treatment, cold working, and natural aging to achieve stable mechanical properties. This alloy is widely used in aerospace structures, aircraft skins, wing spars, fuselage frames, and high-stress structural components. It is also common in military equipment, truck frames, and precision machined parts where high strength and fatigue resistance are critical.

2024 T3 is not recommended for welding due to its susceptibility to hot cracking and loss of strength in the heat-affected zone. It offers good corrosion resistance when properly protected with cladding or coatings, but is susceptible to intergranular corrosion if not sealed. Common product forms include sheet, plate, bar, rod, and extruded shapes.

2.0 Core Technical Properties & Sizing

- Density: 2.78 g/cm³ (0.100 lb/in³)
- Melting point: 502–638°C (935–1180°F)
- Tensile strength (T3): 470 MPa (68,000 psi) minimum
- Yield strength (T3): 325 MPa (47,000 psi) minimum
- Elongation at break (T3): 10% minimum in 2 inches
- Hardness (Brinell): 120 HB typical
- Modulus of elasticity: 73.1 GPa (10.6 × 10⁶ psi)
- Shear strength: 285 MPa (41,000 psi)
- Fatigue strength (5×10⁸ cycles): 140 MPa (20,000 psi)
- Standard sheet thicknesses: 0.016 to 0.250 inches (0.4 to 6.35 mm) in increments of 0.005 inches
- Standard plate thicknesses: 0.250 to 6.000 inches (6.35 to 152.4 mm)
- Standard bar/rod diameters: 0.125 to 8.000 inches (3.175 to 203.2 mm)
- Thickness tolerance (sheet): ±0.002 inches for thicknesses up to 0.064 inches; ±0.003 inches for 0.065–0.128 inches
- Flatness tolerance (plate): 0.005 inches per foot maximum deviation
- Squareness tolerance (bar/rod): ±0.005 inches per inch of cross-section
- Surface finish: mill finish, bright, or with Alclad coating (per ASTM B209)

3.0 Processing, Machinability & Application

2024 T3 aluminum offers excellent machinability, rated at 80% of free-machining brass. It produces tight, continuous chips that require proper chip control. Carbide tooling is recommended for high-speed operations, while high-speed steel (HSS) tools can be used for lower production runs. Flood coolant with a water-soluble oil emulsion is essential to prevent work hardening and to maintain surface finish.

- Recommended cutting speed (carbide): 600–1000 SFM (183–305 m/min) for turning; 800–1200 SFM (244–366 m/min) for milling
- Feed rate (turning): 0.005–0.015 inches per revolution (0.13–0.38 mm/rev)
- Feed rate (milling): 0.002–0.006 inches per tooth (0.05–0.15 mm/tooth)
- Depth of cut: up to 0.250 inches (6.35 mm) for roughing; 0.010–0.050 inches (0.25–1.27 mm) for finishing
- Use sharp, polished carbide inserts with a positive rake angle (10–15°) to minimize built-up edge
- For drilling: use 118° split-point drills at 200–300 SFM (61–91 m/min) with pecking cycles to clear chips
- Tapping: use spiral-point taps with 50–70% thread engagement; apply high-quality tapping fluid
- Welding: not recommended for structural applications; if required, use ER4043 or ER5356 filler with preheat (150–200°C) and post-weld heat treatment to restore temper
- Forming: good formability in T3 temper; bend radius should be at least 2× material thickness for 90° bends
- Heat treatment: solution treat at 495°C (923°F) for 1 hour, quench in water, then age naturally for 4–5 days to achieve T3 temper

4.0 Common Defects & Quality Control

- Reject if surface has visible cracks, laps, or seams under 5× magnification
- Reject if surface pits exceed 0.005 inches (0.13 mm) in depth or 0.030 inches (0.76 mm) in diameter
- Reject if delamination or intergranular corrosion is detected via eddy current or dye penetrant inspection
- Reject if flatness deviation exceeds 0.005 inches per foot on plate or sheet
- Reject if thickness is out of tolerance by more than ±0.003 inches for sheet or ±0.005 inches for plate
- Reject if bar or rod has out-of-roundness greater than 0.002 inches per inch of diameter
- Reject if tensile strength is below 470 MPa or yield strength below 325 MPa per ASTM B209
- Reject if elongation is less than 10% in 2 inches
- Reject if hardness (Brinell) is outside 110–130 HB range
- Reject if chemical composition deviates from ASTM B209 limits: Cu 3.8–4.9%, Mg 1.2–1.8%, Mn 0.3–0.9%, Si ≤0.5%, Fe ≤0.5%, Zn ≤0.25%, Ti ≤0.15%, balance Al
- Acceptable surface finish: no scratches deeper than 0.001 inches (0.025 mm) or wider than 0.010 inches (0.25 mm)

5.0 Storage, Handling & WHMIS Guidelines

- Store in a dry, climate-controlled environment with relative humidity below 50% to prevent corrosion
- Temperature range: 10–30°C (50–86°F); avoid condensation by allowing material to acclimate before unpacking
- Shelf life: indefinite when stored properly; use FIFO to avoid surface oxidation from prolonged storage
- WHMIS classification: Not classified as hazardous under WHMIS 2015 for solid form; dust or fines may be combustible
- Hazard statements: H335 (may cause respiratory irritation from dust), H373 (may cause damage to organs through prolonged or repeated exposure to dust)
- Precautionary statements: P261 (avoid breathing dust/fume), P281 (use personal protective equipment as required), P304+P340 (if inhaled: remove to fresh air and keep at rest)
- Mandatory PPE: safety glasses with side shields, cut-resistant gloves (ANSI A4 or higher), and steel-toed boots during handling
- For machining: use local exhaust ventilation to control airborne dust; wear N95 respirator if dust levels exceed OEL (10 mg/m³ total dust, 5 mg/m³ respirable)
- Fire hazard: aluminum dust is combustible; avoid accumulation of fines; use Class D fire extinguisher (dry powder) for

metal fires

- Spill procedure: sweep or vacuum dust carefully to avoid airborne dispersion; do not use water on molten aluminum
- Disposal: recycle as scrap metal; do not dispose in landfill; follow provincial regulations for metal waste

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