
4140 Chromoly Alloy Steel – Technical Material Specification

1.0 Material Overview & Common Uses

4140 Chromoly Alloy Steel is a low-alloy steel containing chromium, molybdenum, and manganese. It offers a balance of strength, toughness, and wear resistance, making it a standard choice for high-stress components in automotive, aerospace, and heavy equipment manufacturing.

- Common applications: axles, shafts, gears, bolts, connecting rods, hydraulic components, and structural parts requiring high tensile strength.
- Available in hot-rolled, cold-finished, annealed, and quenched & tempered conditions.
- Often used as a direct substitute for 4340 when lower hardenability is acceptable.

2.0 Core Technical Properties & Sizing

- Density: 7.85 g/cm³ (0.284 lb/in³)
- Melting point: approximately 1427°C (2600°F)
- Tensile strength (annealed): 655 MPa (95,000 psi) minimum; (quenched & tempered): 850–1000 MPa (123,000–145,000 psi)
- Yield strength (annealed): 415 MPa (60,000 psi) minimum; (Q&T): 700–850 MPa (101,000–123,000 psi)
- Elongation in 50 mm: 25% (annealed), 12–18% (Q&T)
- Hardness (annealed): 197 HBW max; (Q&T): 28–35 HRC typical
- Standard round bar diameters: 1/4 inch to 12 inches (6.35 mm to 304.8 mm)
- Standard flat bar thickness: 1/8 inch to 6 inches (3.175 mm to 152.4 mm)
- Diameter tolerance (cold-finished): ±0.002 inches for sizes up to 3 inches; ±0.003 inches for 3–6 inches
- Length tolerance: +1/8 inch, -0 inch for standard mill lengths (12–20 feet)

3.0 Processing, Machinability & Application

4140 is considered to have good machinability in the annealed condition (approximately 70% of AISI 1212). In the hardened condition, machinability decreases and carbide tooling is recommended. Welding requires preheat and post-weld heat treatment to avoid cracking.

- Recommended cutting speed (HSS tools, annealed): 80–100 SFM (surface feet per minute) for turning; 60–80 SFM for drilling.
- Carbide tooling (annealed): 300–400 SFM turning; 150–200 SFM drilling.
- Use a 30-degree helix end mill for slotting and profiling; feed rate 0.002–0.005 inch per tooth.
- Flood coolant with water-soluble oil is mandatory to prevent work hardening and tool wear.
- Welding: Preheat to 300–400°F (150–200°C) for sections over 1 inch; maintain interpass temperature below 600°F (315°C).
- Post-weld heat treatment: stress relieve at 1100–1200°F (595–650°C) for 1 hour per inch of thickness.

- Heat treatment: Austenitize at 1550–1600°F (845–870°C), quench in oil, temper at 400–1200°F (205–650°C) depending on desired hardness.

4.0 Common Defects & Quality Control

- Reject if surface seams or laps exceed 0.005 inch depth on cold-finished bars.
- Reject if decarburization depth exceeds 0.010 inch per side on machined surfaces.
- Reject if hardness variation exceeds ± 3 HRC across the cross-section of a heat-treated part.
- Reject if non-metallic inclusions (sulfides, oxides) are visible under 10x magnification in critical sections.
- Reject if straightness deviation exceeds 1/8 inch in 10 feet for precision ground bars.
- Reject if surface pitting or rust covers more than 5% of the surface area on any single piece.
- Acceptance criteria per ASTM A29/A29M for chemical composition: C 0.38–0.43%, Mn 0.75–1.00%, Cr 0.80–1.10%, Mo 0.15–0.25%.

5.0 Storage, Handling & WHMIS Guidelines

- Store indoors in a dry, climate-controlled environment below 50% relative humidity to prevent rust.
- Shelf life: indefinite if stored properly; FIFO recommended to avoid surface oxidation on long-stored stock.
- WHMIS classification: Not classified as a hazardous material in solid form. Dust or fumes from grinding/welding may contain chromium and molybdenum compounds.
- Mandatory PPE during machining/welding: NIOSH-approved N95 respirator, welding fume extractor, safety glasses with side shields, cut-resistant gloves, and flame-resistant clothing.
- Do not use compressed air to clean surfaces; use HEPA-filtered vacuum to avoid airborne metal dust.
- Wash hands thoroughly after handling; do not eat or drink in work areas.
- Dispose of scrap metal in designated recycling bins; do not mix with general waste.

Regulatory Disclaimer: This document is a generic technical material specification provided for educational purposes. The end-user assumes all liability for reviewing, adapting, and validating all tolerances, properties, and safety protocols against specific OEM data sheets and local regulations before deployment.