

Titanium Grade 2 (Commercially Pure) – Technical Material Specification

1.0 Material Overview & Common Uses

Titanium Grade 2 is a commercially pure (CP) titanium alloy (UNS R50400) containing a minimum of 99.0% titanium with trace amounts of iron (max 0.30%), oxygen (max 0.25%), carbon (max 0.08%), nitrogen (max 0.03%), and hydrogen (max 0.015%). It offers an excellent balance of strength, ductility, and corrosion resistance, making it the most widely used grade of CP titanium.

Common industrial applications include chemical processing equipment (heat exchangers, reactors, piping), marine components (shafts, propellers, seawater piping), aerospace non-structural parts (ducting, fairings), medical implants (surgical instruments, bone plates), automotive exhaust systems, desalination plants, and architectural cladding. It is also used extensively in the oil and gas industry for downhole tubing and valves due to its resistance to sour service environments.

2.0 Core Technical Properties & Sizing

- Density: 4.51 g/cm³ (0.163 lb/in³)
- Melting Point: 1660°C (3020°F)
- Tensile Strength (min): 345 MPa (50 ksi) per ASTM B265
- Yield Strength (0.2% offset, min): 275 MPa (40 ksi)
- Elongation in 2 inches (min): 20%
- Hardness: 80 HRB (Rockwell B) typical; 160 HV (Vickers) typical
- Modulus of Elasticity: 105 GPa (15.2 × 10⁶ psi)
- Thermal Conductivity: 16.4 W/m·K at 20°C
- Electrical Resistivity: 0.56 µΩ·m at 20°C
- Standard Sheet/Plate Thickness: 0.016 inch (0.4 mm) to 2.0 inch (50.8 mm) per ASTM B265
- Standard Sheet Width: 36, 48, 60 inches (914, 1219, 1524 mm)
- Standard Plate Width: 48, 60, 72 inches (1219, 1524, 1829 mm)
- Length Tolerance: +0.25 inch / -0.00 inch for sheared or saw-cut edges
- Flatness Tolerance: 0.005 inch per foot (0.42 mm/m) for annealed sheet; 0.010 inch per foot (0.83 mm/m) for plate
- Thickness Tolerance (sheet, 0.025–0.125 inch): ±0.003 inch
- Thickness Tolerance (plate, 0.188–0.500 inch): ±0.010 inch
- Surface Finish: Mill finish (2B) or pickled (2D) per ASTM A480

3.0 Processing, Machinability & Application

Titanium Grade 2 is considered moderately machinable (rating ~40% of free-machining steel). It exhibits a tendency to gall and work-harden, requiring sharp tooling, rigid setups, and generous coolant flow. Carbide or polycrystalline diamond (PCD) tooling is recommended for production runs. High-speed steel (HSS) tools may be used for low-volume work but will wear rapidly.

- Cutting Speed (carbide turning): 30–60 m/min (100–200 SFM) with coated carbide inserts (C2 grade).
- Feed Rate (turning): 0.10–0.30 mm/rev (0.004–0.012 in/rev).
- Depth of Cut: 1.0–4.0 mm (0.040–0.160 in) for roughing; 0.25–0.75 mm (0.010–0.030 in) for finishing.
- Use high-pressure flood coolant (water-soluble oil, 5–10% concentration) to prevent chip welding and heat buildup.
- Drilling: Use 135-degree split-point carbide drills; peck cycle recommended for holes deeper than 3× diameter.
- Tapping: Use spiral-point taps with TiN coating; thread milling preferred for blind holes.
- Sawing: Use bi-metal or carbide-tipped blades with variable pitch (10–14 TPI for thin sheet, 4–6 TPI for plate).
- Waterjet cutting: Preferred for complex profiles; use 60–80 mesh garnet abrasive at 55,000–60,000 psi.
- Laser cutting: CO₂ laser with nitrogen assist gas for clean edges; avoid oxygen assist to prevent oxide embrittlement.
- Welding: TIG (GTAW) with pure argon shielding (99.995% min) is standard. Use ERTi-2 filler wire. Pre-heat not required for sections under 1 inch. Post-weld heat treatment (stress relief at 540–650°C for 1 hour) recommended for complex assemblies.
- Welding parameters (1/8 inch sheet): 80–120 amps DCEN, 10–15 CFH argon flow, 1/16 inch 2% thoriated tungsten electrode.
- Brazing: Use silver-based filler metals (e.g., BAg-8) with flux; vacuum brazing preferred to avoid oxidation.
- Forming: Bend radius should be 2–3× material thickness for sheet; hot forming at 300–500°C for tight radii.
- Annealing: 700–750°C for 30–60 minutes, air cool. Do not quench to avoid distortion.

4.0 Common Defects & Quality Control

- Reject if surface pits exceed 0.005 inch (0.13 mm) depth or 0.020 inch (0.5 mm) diameter.
- Reject if longitudinal cracks, laps, or seams are visible under 5× magnification.
- Reject if delamination is detected via ultrasonic testing (ASTM E2375, Class A acceptance criteria).
- Reject if out-of-flatness exceeds 0.010 inch per foot (0.83 mm/m) for plate or 0.005 inch per foot (0.42 mm/m) for sheet.
- Reject if thickness is below minimum tolerance per ASTM B265 (e.g., 0.125 inch nominal sheet must not measure less than 0.122 inch).
- Reject if chemical composition deviates from UNS R50400 limits (Fe > 0.30%, O > 0.25%, C > 0.08%, N > 0.03%, H > 0.015%).
- Reject if tensile strength is below 345 MPa or yield strength below 275 MPa per ASTM E8/E8M.
- Reject if elongation is less than 20% in 2 inches.
- Reject if hardness exceeds 85 HRB (Rockwell B) or 170 HV (Vickers).
- Reject if surface contamination (iron, grease, or embedded particles) is detected via white light inspection or wipe test.
- Reject if alpha case (oxygen-enriched brittle layer) is present on hot-worked surfaces exceeding 0.003 inch depth.
- Reject if weld porosity exceeds 1/16 inch (1.6 mm) diameter per AWS D1.9 Class B.
- Reject if edge condition shows burrs > 0.005 inch (0.13 mm) or sharp edges that could cause injury.

5.0 Storage, Handling & WHMIS Guidelines

- Store in a clean, dry environment at 15–25°C (59–77°F) with relative humidity below 50% to prevent surface contamination.
- Do not store titanium in direct contact with carbon steel, copper, or brass to avoid galvanic corrosion and iron

contamination.

- Use plastic or rubber separators between stacked sheets or plates to prevent scratching and galling.
- Shelf life: Indefinite under proper storage conditions; no degradation of mechanical properties over time.
- FIFO protocol: Rotate stock by heat number and date of receipt; use oldest material first to avoid mix-ups.
- WHMIS Classification: Not classified as a hazardous material under WHMIS 2015 (solid form). However, titanium dust and fines are combustible and may form explosive mixtures in air.
- WHMIS Hazard Statements (dust/fines): H228 (Flammable solid), H261 (Contact with water liberates flammable gas), H335 (May cause respiratory irritation).
- Mandatory PPE for handling: Cut-resistant gloves (ANSI A4 or higher), safety glasses with side shields, and steel-toed boots. For machining: use a NIOSH-approved N95 respirator if airborne dust is generated.
- Fire safety: Use Class D extinguisher (dry powder) for titanium fires. Do not use water, CO₂, or halon as they may cause violent reactions.
- Spill procedure: Sweep up dry dust carefully to avoid creating airborne clouds. Place in a sealed metal container. Do not use vacuum cleaners unless explosion-proof.
- Disposal: Recycle as scrap titanium. Do not mix with other metals. Follow local regulations for hazardous waste if contaminated with oils or solvents.
- First aid: For skin contact with dust, wash with soap and water. For eye contact, flush with water for 15 minutes. Seek medical attention if irritation persists.

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