

Grades for Outstanding Corrosion Resistance

Grade 2

Properties

Grade 2 titanium is a commercially pure grade renowned for its exceptional corrosion resistance, particularly in oxidizing and mildly reducing environments. Its resistance to saltwater, chlorides, and chemical compounds makes it highly durable in aggressive conditions. With a tensile strength of around 344 MPa and excellent ductility, this alloy is both easy to form and weld, making it versatile for industrial use.

Machining Considerations

While easier to machine than alloyed titanium grades, Grade 2's relatively low hardness introduces challenges like burr formation and chip adhesion. To ensure smooth machining, consider the following approaches:

- **Tool Selection:** Use uncoated carbide or high-speed steel (HSS) tools with sharp cutting edges to avoid smearing the material.
- **Cutting Speeds:** Moderate speeds (60–100 m/min) and low feed rates reduce burring and improve surface finish.
- **Coolant:** Standard water-based coolants work well to reduce heat buildup, enhance cutting efficiency, and prevent galling.
- **Chip Control:** Use proper chip breakers to handle long, stringy chips that can wrap around tools and workpieces.

Applications

Grade 2 titanium is a go-to material for industries requiring reliable corrosion resistance:

- **Marine Equipment:** Components such as boat hulls, propellers, and heat exchangers exposed to seawater.
- **Chemical Processing:** Pipelines and reaction vessels handling acidic and neutral chemical solutions.
- **Architecture:** Structural elements in coastal areas where saltwater exposure is common.

Grade 7

Properties

Grade 7 is similar to Grade 2 in purity but includes a small addition of palladium ($\approx 0.12\text{--}0.25\%$), significantly enhancing its resistance to aggressive environments like strong acids and chloride-rich settings. The palladium addition provides superior performance in reducing environments, such as those found in chemical or industrial waste systems. With a tensile strength of approximately 414 MPa, Grade 7 also offers slightly higher strength than Grade 2.

Machining Considerations

Although tougher due to the presence of palladium, Grade 7 can still be machined effectively with proper techniques:

- **Tooling:** Opt for carbide tools with high wear resistance. TiAlN-coated tools are excellent for longer tool life.
- **Cutting Speeds:** Operate at slower speeds (30–70 m/min) to combat the material's higher toughness.
- **Coolant:** Flood cooling is essential in these applications to prevent overheating and reduce thermal deformation.
- **Finishing:** Perform semi-finishing and finishing passes using sharp tools to achieve smooth surface finishes required in chemical and marine applications.

Applications

Grade 7's outstanding corrosion resistance makes it essential in environments with high acidity or chloride content:

- **Desalination Plants:** Pipes and components exposed to brine and seawater.
- **Pollution Control:** Equipment for handling acidic waste streams and chemical pollution.
- **Chemical Industry:** Heat exchangers and reactor linings designed for aggressive chemical mixtures.

Summary Table

Titanium Grade	Key Characteristics	Machining Considerations	Applications
Grade 2	Commercially pure, excellent corrosion resistance in oxidizing/mildly reducing environments	Use sharp carbide tools; moderate speeds (60 - 100 m/min); low feed rates; proper chip control	Marine equipment, chemical processing pipelines, architectural structures
Grade 7	Similar to Grade 2 but with added palladium for enhanced resistance to acids/chlorides	Use TiAlN-coated carbide tools; slower speeds (30 - 70 m/min); essential use of flood cooling	Desalination systems, pollution control equipment, chemical processing heat exchangers

By leveraging the unique properties and machining techniques of Grade 2 and Grade 7 titanium, manufacturers can meet the demands of applications in environments that require supreme corrosion resistance. Proper tooling, optimized machining strategies, and cooling techniques will ensure successful outcomes in even the most challenging conditions.