C A B O T   S U P E R M E T A L S

Product Information

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Niobium Processing and Fabrication

General:
Niobium has a body-centered cubic structure. It has moderate density -- about half that of tantalum and about 10% greater than that of iron. In cold working, such as rolling, niobium can be reduced as much as 90% in cross sectional area before annealing becomes necessary.

Available Niobium and Nb1Zr

Recommendations for Machining Niobium and Nb1Zr	
Tool Shape	
Approach Angles	15° to 20°
Side Rake	30° to 35°
Side and End Clearances	5°
Plane Relief Angle	15° to 20°
Nose Radius	0.005 in. to 0.030 in.
Cutting Speed	High speed steel: 80 to 120 surface ft./min. Carbide cutting tools: 300 to 350 surface ft./min.
Feed	Rough, 0.008in. to 0.12 in. Finish, 0.005 in max.
Depth of Cut	0.030 in. to 0.125 in.

Niobium reacts with atmospheric oxygen at temperatures as low as 230°C (446°F), although the reaction rate at this temperature is relatively slow. The metal should not be exposed to the atmosphere above 370°C (700°F) for longer than a few minutes. At lower temperatures, a thin adherent oxide film forms on the surface. Long exposures at low temperatures or short expose at high temperatures results in a thick film that spalls, thereby exposing fresh metal to oxidation. Oxygen diffuses into the base metal to cause embrittlement.Niobium reacts with most gases at higher temperatures, including nitrogen, hydrogen, water vapor, carbon dioxide and carbon monoxide. Annealing operations use a high vacuum (10-4 Torr min.) or an inert atmosphere.

Machining:
All of the normal machining techniques can be used for niobium. The metal has a strong tendency to gall and special attention must be given to tool design and lubricant use.

In lathe turning, the metal behaves very much like soft copper. The use of high speed tooling requires adequate lubrication and cooling using water soluble oil or vegetable oil.

Although carbide tools can be used, the tendency to gall is more pronounced than with high speed steel. In turning, the metal should be removed in a shaving action and the chip allowed to slide off the tool surface. When build-up of the chip occurs, the resulting pressure breaks the cutting edge of the tool. A minimum surface speed of 80 ft./min. is important. Slower speeds will cause the metal to tear, particularly annealed stock. Unannealed metal is preferred for lathe operations.

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Drilling:
Standard high speed drills can be used with good results. The peripheral lands of the drill should be checked often for excessive wear to prevent drilling undersized holes.

Thread Cutting:
Standard techniques for thread cutting can be used. Sufficient lubricant is required to eliminate galling and tearing. In threading larger diameters, it is better to cut the threads on a lathe rather than with a threading die. When dies or taps are used, they must be kept free of chips and cleaned frequently.

Grinding:
Grinding niobium is difficult. Most grinding wheels have a tendency to "load" Silicon carbide wheels such as Carborundum 120-T (for rough grinding) and 120-R or 150-R (for finishing) are suggested. An adequate supply of cooling water is desirable.

Cleaning:
Prior to annealing or joining, the metal must be cleaned to remove all traces of lubricant, soil, and oxide. Niobium reacts with common gases as well as contaminants such as oil, grease, and even residues from degreasing. Parts should be degreased in hydrocarbons or alkaline cleaners and rinsed in distilled or deionized water.

Fusion Welding:
Strong, ductile niobium welds can be made using TIG welding. Because niobium reacts with air above 230°C, certain modifications to the TIG process are required. It is best to weld in a chamber using argon or a mixture of argon and helium as a cover gas. If chamber welding is not practical or not available, welding in normal atmosphere can be done with proper fixturing to provide an inert gas atmosphere for the molten zone. Trailing shields are necessary to protect the fusion zone during cooling, and the metal must not be exposed to air until the temperature has dropped to 230°C (446°F). The back side of the weld zone also must be protected by an inert gas shield during both the welding and cooling cycles.

Sheets with thicknesses of 0.050 in. (1.27 mm) or less can be welded without using a filler rod. Cleanliness of the material to be welded and the filler rod is essential. Heavier sheet often requires use of a filler rod; bare rod should not be used. Use of a coated rod or flux is not recommended since molten niobium reacts with all of the known fluxes.

Electron Beam Welding:
Electron Beam (EB) welding is commonly used to join thick sections, but can also be advantageous for very thin sections. EB welds in thick sections, up to 0.75 in. (19 mm) are narrower and deeper than those produced by other methods. When joining thin sections, the narrow weld zone helps reduce distortion. Other than care in welding and cleanliness of parts, normal electron beam welding procedures are adequate.

Blanking and Punching:
Dies and punches made of steels generally used for punching and blanking are satisfactory for niobium. Allowance of 6% of the metal thickness for clearance between the punch and die is recommended. Light oils or similar lubricants should be used to prevent scoring the dies.

Engineering support is readily available for specific applications.

Additional information available at www.cabot-corp.com

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