MOLYBDENUM TOTAL SERVICES

Machining Molybdenum

Molybdenum Overview

Similar to medium hard cast iron, pressed and sintered or recrystallized molybdenum has high machinability. Wrought molybdenum is comparable to stainless steel under various machining mechanisms, and moly can be machined with conventional machine shop equipment. However, molybdenum is unique in relation to medium hard cast iron or cold rolled steel in that dull cutting tools cause the edges to break out during molybdenum machining operations. Additionally, the material is very abrasive, causing tools to wear our much quicker than normal iron or steel.

Turning and Milling

Utilizing cast iron as a similar material, tools for machining molybdenum should be ground to angles and rakes during outside and inside turning. Speeds up to 200 feet per minute, with depths up to 1/8", are acceptable for rough turning. The ideal feed is 0.015 inches per rotation. For finishing work, utilize speeds up to 400 feet per minute, with a depth cut of 0.005" to 0.015", and a feed of 0.005" to 0.010". When turning, the depth of the cut needs to be greater than 0.005". Anything under 0.005" will cause the tools to wear out faster. Sulphur cutting oil can be utilized as lubricant for roughing cuts, and either kerosene or sulphur cutting oils may be used in finishing applications. The benefit of using lubricants during moly machining is to avoid wear and tear on the tools, but avoid using the lubricants with electronic applications. Chlorinated oils are ideal for a machining lubricant, as molybdenum tends to chip when being machined. Use plenty of coolant, and avoid face-milling, if possible. If not, use cutters with carbide tips. Similar to lathe cutting, the depth and speed of the cut should be comparable to those applied during lathe turning, with a depth less than or equal to 0.050". We recommend that plates greater than 0.050" thick be edge machined rather than sheared. Edge machining can be carried out on a shaper or a milling machine, and the machining is best completed along the edge, as opposed to across the edge. To avoid chipping, secure the molybdenum between two steel plates.

Drilling, Tapping and, Threading

The best way to drill molybdenum is with high speed steel drills, or carbide drills for deep drilling, combined with cutting oils. Make sure to back up the work piece so as to avoid breakout at the exit hole. The drill speed for machining moly is best at a rate of 30 to 50 feet per minute

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with a feed of 0.003 inches per revolution. Molybdenum has a tendency to chip, so depth during threading should not be more than 50% - 60%. Molybdenum can be rolled threaded, but this method is slow, and the preferred, faster methods consist of turning or chasing. Heat the moly and the die to 162°C for best results. Molybdenum can be heated to 162°C in air without the danger of oxidation, but the temperature should not exceed 260°C except in protective atmospheres. While slower, Electrical Discharge Machining (EDM) is alternative to molybdenum drilling, tapping, or threading.

Sawing

You can easily saw molybdenum with power band saws or hack saws, but abrasive saws work equally well. Approximately 1/8" should be allowed for the kerf end and 3/16" for the camber of heavier sections. The most effective blades are high speed steel that have a hardened tooth area. Coolant is not required, but can be used.

EDM & ECM

Crafting molybdenum works especially well with both Electrical Discharge Machining (EDM) and Electrochemical Machining (ECM) methods. Through EDM, machinists can achieve removal rates of up to 0.5" cubed per minute and +/- 0.0005" tolerances. ECM is normally capable of removal at approximately 1" cubed per minute at 10,000 amps. While EDM is preferred for complex shapes, ECM is especially effective in producing ultra-fine finishes.

Grinding

Grinding is typically used for surface finishing and removing impurities, as opposed to stock removal. No molybdenum-specific equipment is required, and you can use traditional machining equipment.

Bending

When properly heated, molybdenum can be formed into intricate shapes. Moly sheets less than 0.020" thick can usually be bent at a 180° angle during normal room temperature conditions.

Punching, Shearing, & Drawing

No new equipment is needed for these processes. Ensure that your tools are in sharp, working condition and that equipment clearances are around 5% of sheet thickness. If you need to make the material more pliable, apply heat and the moly will machine more easily.

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Welding

Like tungsten, the best method to weld molybdenum is to first apply chemical cleaning to remove impurities, followed by welding in vacuum. During TIG welding, utilize run-off tabs to avoid crater cracking at the end of each pass. Use DCEN polarity and make sure heat input is kept to a minimum to avoid oxidation. After welding, you can restore some of the element's ductility through stress relieving methods, or by grinding the material to remove surface contaminants. Note that if you weld the pure molybdenum in the open atmosphere, the material is at risk of absorbing the nitrogen and oxygen, thus causing oxidation and causing brittleness.

Cleaning

Cleaning molybdenum is an easy and straightforward process. By volume, the cleansing solution consists of 50% nitric acid mixed with approximately 10% hydrofluoric acid (ASM Handbook Series, Volume 5). The ideal range to heat the solution is 50 - 65°C, and the mixture will not only remove the oxides, but will also clean off any residual copper that is accumulated during the EDM process. After cleaning the moly with the solution, douse the parts in water and allow them to dry.

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