The main property of pure molybdenum which has influence on its machinability is its grain structure. In the “as sintered” condition, it can be machined relatively easily, but it is somewhat more difficult to machine after working. Molybdenum that has undergone a considerable amount of working is best machined if it has a uniformly fine grained and fibrous structure.

Molybdenum machines with the crumbling chip which is characteristic of hardened SAE 1040 steel. While it is possible to machine molybdenum with high speed steel tools, tungsten carbide tools are generally recommended for better tool life. Very satisfactory results are obtained with Grade 2A5 Vascoloy Ramet tools.

**Turning and Milling Molybdenum:**

For inside and outside turning, tools should be ground to angles and rakes similar to those used for cast iron. Correct tool shapes are illustrated in “Machinery’s Handbook”, and in the literature of carbide tool manufacturers. Speeds up to 200 feet per minute, with a depth of cut up to 1/8”, are satisfactory for rough turning. The feed should be 0.015 i.p.r. For finishing work, 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", should be used.

It is very important, in turning, that the depth of cut always be greater than 0.005". If depth cut is less, tool wear will be excessive.

Sulphur base cutting oil can be used as a lubricant for roughing cuts, and kerosene or sulphur base cutting oil can be used for finishing work. If lubricants are not used, tool wear will be excessive. Sulphur base oils cannot be used for machining electronic parts. Chlorinated oil and solvents have proved very satisfactory as a machining lubricant.

Molybdenum has a tendency to chip while being machined, and care must be taken to prevent this. Work should be firmly chucked, tools rigidly supported, and machines should be sufficiently powerful and free from chatter or backlash. A copious supply of coolant is essential.

Face milling is not generally recommended. It may be accomplished when necessary, however, by the use of carbide tipped cutters. The speeds and depth of cut should be similar to those used in lathe turning, except that the depth of cut should not exceed 0.050”.

Molybdenum plates can be edge machined. In fact, plates thicker than 0.050” should be edge machined rather than sheared to finished dimensions. This work can be done either on a shaper or milling machine, and the machining should be done along the edge, rather than across the edge. The molybdenum should be clasped between steel plates while being machined to avoid chipping the edges.

**Drilling, Threading and Tapping Molybdenum:**

Molybdenum can be drilled with high speed steel drills, although carbide drills are recommended for very deep drilling. When using high speed steel drills, the speed should be 30 to 50 feet per minute with a feed of 0.003 i.p.r. A cutting oil should be used for all drilling, tapping or threading.

Some difficulty may be experienced in threading or tapping. The thread depth should not be more than 50 to 60 percent, because of the tendency of molybdenum to chip. Rethreading or retapping should not be attempted at any time.

Molybdenum can be rolled threaded. In this operation, the molybdenum stock and the die should be heated to approximately 325 °F. It is neither necessary nor desirable to heat molybdenum beyond this temperature, since it attains ample workability at that point. Molybdenum can be heated to 325 °F in air without danger of oxidation, but must not be heated to temperatures above 500 °F except in hydrogen or other approved protective atmosphere.
Sawing:

Power hacksaws and band saws are used effectively to cut mill products of molybdenum to suitable lengths for subsequent machining or to produce rough shapes with plane surfaces. Both types of saws are widely used by ships that machine molybdenum parts. The most effective blades are made of high speed steel with only the tooth area hardened. It is not necessary to use a cutting fluid, but a soluble oil coolant flowing through the hacksaw cut will remove the chips and extend blade life.

Electrical Discharge Machining:

Electrical discharge machining (EDM), or spark machining, may be used to produce small and irregular shaped holes and slots in molybdenum. The process is also useful for producing cavities of complex shapes in molybdenum bars or forgings. EDM is particularly well suited for machining intricate parts for the electronic industry, especially ‘cut-outs’ in thin molybdenum sheet. EDM wire machining can be used effectively for straight edges of internal openings or slits too thin for sawing or milling operations.

Electrical discharge machining is accomplished by rapidly recurring electrical discharges between an electrode and the workpiece in a dielectric fluid. The electrode is always negative and the workpiece is positive. The electrode for machining molybdenum is usually graphite, but equally satisfactory results can be obtained with copper, brass, or molybdenum electrodes.

The spark discharge, as it accomplishes the removal of metal from the workpiece, forms small craters on the surface that is generated. The tiny craters comprise part of a surface layer of disturbed metal that may be 0.0001” to 0.001” thick; surface roughness may be in the range of 25 to 250 microinches (0.625 to 6.25 microns). The thin surface layer may also contain microcracks that could affect the performance of molybdenum parts adversely if the surface is stressed in tension. For many applications, therefore, the surfaces formed by electrical discharge machining should be ground or polished with abrasive cloth to remove the damaged layer. The layer may also be removed by chemical milling or electropolishing.

EDM has been used successfully to bore a hole 0.125” diameter and 12” long in a bar of molybdenum. A brass electrode was used for the operation, and the hole was machined from both ends. The process can also be used effectively for trepanning molybdenum; for example, the axial hole in an experimental, molybdenum alloy, tube extrusion blank was machined by EDM, using a hollow carbon electrode. The hole was 1.0” in diameter and 6” long; a core or solid bar, 0.80” in diameter and 6” long was produced simultaneously.