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TECH BRIEFS

Electrical Discharge Machining (Spark Erosion) of Copper Beryllium

Electrical Discharge Machining (also known as EDM or spark erosion) is commonly used to produce molds and dies, to drill small, burr free holes and to make prototype quantities of contacts for the aerospace and electronic markets. Two types of EDM are employed: conventional (ram) EDM and traveling wire (TW) EDM. Effectiveness of EDM is not dependent on the strength or hardness of the work piece, and it is used to machine copper beryllium in its age hardened state with no effect on the alloy's strength and no further heat treatment is required.

CONVENTIONAL EDM

EDM is a thermoelectric process which erodes material from the work piece by a series of discrete sparks between it and the electrode.

Conventional EDM, shown in Figure 1, utilizes a copper or graphite electrode configured like the cavity desired in the work piece. Machining speeds are determined by the area of the work piece, the type of material, and the machining conditions. Since copper beryllium exhibits high electrical conductivity, machining rates are typically 20% lower than those of tool steels. Therefore, prior to EDM, conventional machining is recommended where appropriate. When EDM'ing copper beryllium, it is suggested that the equipment parameters be first set at the machine manufacturer's recommendations for copper and then adjusted accordingly to produce the desired results.

Compared to steel, copper beryllium must be EDM'ed with low amperage and high voltage to produce acceptable results. The polarity of the solid state power supply can be either electrode positive or negative. Electrode negative polarity produces the highest metal removal rates and a rougher surface. Recently, it has become more common to use electrode positive polarity to increase the work to-electrode wear ratio while providing a smoother surface. A dielectric fluid is required in all EDM operations. The dielectric acts as a spark conductor, a coolant, and a flushing medium that carries away swarf. For conventional EDM the most common dielectric fluid used is light petroleum based oil.

The surface texture of EDM'ed copper beryllium resembles overlapping, small craters that exhibit no directionality. The surface roughness can range from 8 microinch (0.2 micrometer) Ra for finishing operations, to 500 microinch (13 micrometer) Ra for roughing operations. Recast and heat affected layers occur on the order of 0.0001 to 0.005 inch (0.002 to 0.1 mm) and should be removed for fatigue ¬sensitive applications. Shot peening provides a smoother surface and improves fatigue life, but abrasive and electrochemical methods are required to remove the recast and underlying heat affected layer. However, for most applications, removal of these softer layers is not necessary.

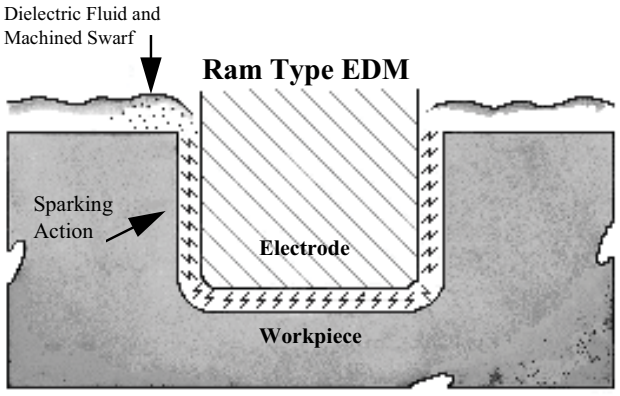


Figure 1 Conventional (RAM) EDM. *EDM machines a work piece by forcing a spark through a dielectric fluid from the electrode to the work piece. As each spark impinges on the work piece surface, it removes a minuscule amount of material that is flushed away with the flowing fluid.*

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TRAVELING WIRE EDM (TW EDM)

Traveling wire EDM (Figure 2) of copper beryllium utilizes the same principles as conventional EDM, with the fun¬damental difference being that a wire electrode is used for straight sided cuts. For TW EDM, brass and copper wire electrodes are most frequently used, with other possibilities being copper tungsten, tungsten and molybdenum. Dielectric cooling of the wire and workplace usually uses deionized water.

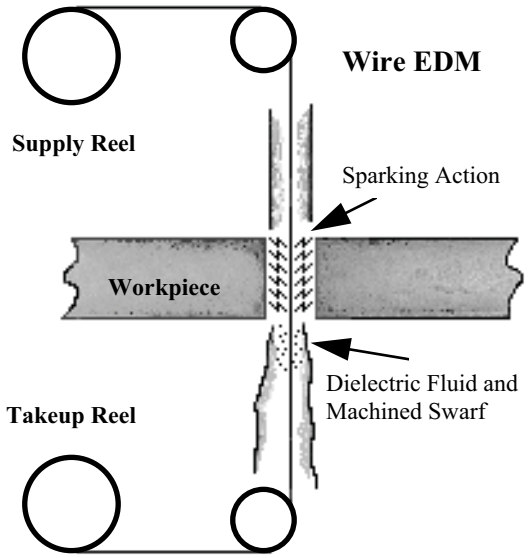


Figure 2 Traveling Wire EDM (TW EDM)

Wire diameters usually range from 0.002 to 0.012 inch (0.05 to 0.3 mm). Since the electrode is only used once, electrode wear is not a concern in most TW EDM. For TW EDM, electrode (wire) negative polarity is used. As with conventional EDM, the machining rates of copper beryllium are typically 20% lower than that of tool steels. TW EDM is used for both roughing and finishing machining. Common practice is to rough cut to about 0.004 inch (0.1 mm) of finished dimensions, then follow with two or three finishing passes. A finishing cut takes about twice as long as a roughing cut, since lower spark energies and a lower metal removal rate must be used. A TW EDM surface exhibits a matte texture with typically 30 to 50 microinch (0.8 to 1.3 micrometer) Ra roughness. The recast and heat affected layers are very small and in most applications, need not be removed. TW EDM is commonly used to produce cores, pins, and stamping dies for the prototype production of parts in small quantities, and to produce precise round or irregular shaped holes as small as 0.002 inch (0.05 mm) in diameter.

SAFE HANDLING OF COPPER BERYLLIUM

As with all machining operations, safety precautions must be taken when EDM copper beryllium. The work piece should be kept wet with the dielectric fluid to reduce airborne particles. For conventional EDM, fumes can result which must be properly ventilated. Generally, all precautions that apply when performing other machining operations on copper beryllium also apply with EDM. Please refer to the Materion Corporation publications “Safety Facts 5 - Safety Practices for Electrical Discharge Machining Copper Beryllium”, and “Safety Facts 105 - Processing Copper Beryllium Alloys.”

Handling copper beryllium in solid form poses no special health risk. Like many industrial materials, beryllium-containing materials may pose a health risk if recommended safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in susceptible individuals. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Material Safety Data Sheet (MSDS) before working with this material. For additional information on safe handling practices or technical data on copper beryllium, contact Materion Brush Performance Alloys, Technical Service Department at 1-800-375-4205.

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