# Technical Spotlight

*Submitted by*

*Company:* **MSI Mold Builders;** 12300 6th Street S.W.; Cedar Rapids, Iowa 52404
*Machine:* **Xermac 80ST**
*Electrode:* **POCO EDM-C200**
*Application:* **Moldmax insert for office equipment mold**

Deep, thin ribs can be difficult to EDM, and the difficulty increases when cutting an exotic metal. Due to the type of molds created by MSI, they often use Moldmax inserts and they are often cutting thin ribs. MSI improved their EDM performance when they switched to a copper impregnated graphite for EDMing Moldmax. This typical thin rib job decreased from 6 electrodes to 3 electrodes. Electrode wear decreased along with the EDM time.

The ribs for this job are 0.035" wide and cut 1" deep into Moldmax. The machine parameters were 40 amps peak current, 50 microseconds on and 30 microseconds off. Jet flush and pulsing, every 3 seconds, were used to keep the gap clean. Total EDM time was 2 hours.

The shape of the electrode also offered some challenges. The basic "X" shape could have been easily cut with 2 electrodes, each representing one half of the "X", but to increase the efficiency of the job one electrode was used. Fabricating the electrode with sharp angles at the center of the "X" required additional work. The Haas machining center left a slight radius at the intersection of the "X" that was not acceptable to the customer. MSI used a secondary operation to achieve sharp angles at the intersection.

**Note:** In this instance, copper impregnated graphite, with a lower electrical reistivity, cut Moldmax faster than a non-impregnated graphite. The higher flexural strength of copper impregnated graphite can also be important for thin rib applications.

Cutting beryllium copper with graphite electrodes often means low metal removal rates with excessive electrode wear. Thin ribs can make it more difficult to achieve a high level of performance. That is why the machining parameters were important on this job. Typically, when a large particle size graphite is used, it is necessary to use long on-times to reduce electrode wear. On this job, the metal removal rate at 35 amps was the same at either 50 or 100 microseconds on-time, but the electrode wear and surface finish were significantly improved at 50 microseconds on-time.

# Machining Tip

## How To Make Chips, OR, Why Surface Footage Doesn't Matter

Many concerned machinists have asked, "What is the proper surface feet per minute to use when cutting graphite". In POCO's EDM Technical Manual guideline, SFM ranges are given for HSS, tungsten carbide and diamond. Many shops cut outside those ranges, or, because of tooling and rpm limitations, can't run in the suggested ranges. For all of these concerns there is a common answer – RELAX!

Graphite is not cut by the same mechanisms as steel, aluminum, and other metals. Metal chips are formed by a ductile deformation process. When cutting at the right speed and chip load, a tiny spot of heat softened metal occurs just in front of the tool's cutting edge. This tiny softened spot makes the metal easier to cut and reduces the power required for the cut. Cutting metal too slow does not generate the proper cutting conditions (heat softened zone), therefore, tool life will be poor. On the other hand, cutting too fast in metal generates too much heat and excess heat shortens tool life.

So, what happens when cutting graphite? Does it soften if we get enough energy going into the cut? Well, not really. Graphite does have certain conditions under which it softens, but those conditions cannot be met under normal atmospheric pressure and oxygen content. The temperature where it occurs is over 3,000°C (5,400°F). Even if you *were* able to cut at this temperature, all the graphite dust would immediately react with oxygen (burn) when it hit your shop's air.

Common mill and lathe tooling cannot withstand the temperatures required to cut graphite in the ductile mode. Instead, graphite is removed by brittle fracture. With fracture, the surface of graphite is broken into tiny little pieces and knocked off. This is exactly where graphite dust comes from. With a scanning electron microscope we can see that dust doesn't have the rounded flowing edges typical of metal chips (see photo 1). The greater the chip load on a cutting edge, the larger these dust particles will be.

So what does brittle fracture mean for surface footage? It means that graphite is not sensitive to cutting at exactly the "right" speed. Every speed in a machine shop will result in nearly the same kind of surface. Graphite can be cut on a slow knee mill or at top speed on the latest high speed CNC machine. High speed machines will finish first of course, but

surface quality of the part is not determined by cutting speed.  So, cut that graphite with whatever speed machine you have and RELAX!