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Things to consider when wire and small-hole EDMing

Electrical discharge machines have been used commercially for more than 30 years, with the tool and die industry being the first to adopt the technology. Since then, other manufacturing sectors have steadily added EDMing to their parts-producing capabilities.

Many applications have been developed recently that involve wire EDMing or small-hole EDMing microscale parts for the medical, nanotechnology and aerospace industries. To ensure success and profitability when serving these markets, part manufacturers need to consider certain aspects of the production process. These include wire and electrode diameter, handling and fixturing, inspection, programming and machine settings.

Let's look briefly at each.

All images: XACT Wire EDM

Small-hole EDMing is performed with a spinning electrode. Shown is a 0.040"-dia. hole being EDMed in a 0.5000"-dia. ball bearing.

Wire size. Standard EDM wire is 0.25mm in diameter. Microwires can range from 0.15mm down to 0.020mm. The wire diameter chosen depends on part features, such as corner radii, slot widths, thin-wall details and intricacy of geometries.

There are drawbacks to using a wire with too small a diameter. The biggest disadvantage is that thin wire is limited in terms of cutting depth. For instance, a 0.15mm wire can hold an accuracy of ±0.002mm on a 22mm-thick part, while a 0.075mm wire is accurate up to just 6mm. The thinner wire could make a deeper cut if tolerance requirements weren't as stringent.

Too-thin wire also can increase production costs. For example, a 0.075mm wire has only 56 percent of the surface area of a 0.10mm-dia. wire. As a result, the thinner wire's burn time is nearly twice that of the thicker wire. One way to speed production is to apply a thicker wire for the majority of the cut, followed by a thinner wire on those areas requiring delicate cutting action.

Electrode size. When small-hole EDMing, a small-diameter, usually hollow, spinning electrode is applied to a workpiece. The process, also known as EDM drilling, traditionally has been used to produce holes between 0.30mm and 6mm in diameter. Electrodes as small as 0.025mm in diameter recently have been introduced for EDM sdrilling.

As with wire, electrode diameter and workpiece thickness must be considered. A 0.30mm-dia. electrode can hold ±0.05mm accuracy in materials up to 8mm thick. A 0.15mm electrode can only maintain that accuracy in parts up to 2.5mm thick.

Besides holemaking, EDM drilling is used to make start-holes for the wire EDMing process. For this application, hole quality is not important. The start hole just needs to be within the geometry being wired.

Wire is more accurate than small-hole EDMing. But for hole-finishing applications where size and roundness tolerances are looser, EDM drilling will be more cost-efficient.

Handling, fixturing. Fixturing workpieces for microscale wire EDMing can prove challenging due to the parts' small size and, oftentimes, their fragility. As with any wire EDM fixture, the highest operating speed and greatest accuracy will result if the part is positioned as close as possible to the machine head.

Because thin wire is difficult to work with, the fixture should facilitate autothreading, and the number of threads needed to produce the part should be limited. The ideal fixture is easy to load and, to ensure a smooth production run, can be done so quickly and accurately.

Stacking parts is another option to consider when designing fixtures. Often, the burn time will be the same whether parts are EDMed singly or stacked two high.

Workpieces must be held securely to avoid any secondary EDMing effect that could destroy the part and fixture. On the other hand, parts can't be held with so much force they deform or collapse.

A good option is to keep a part in the same fixture as it moves through multiple operations, including inspection. This facilitates handling and improves part accuracy.

Inspection. Traditional methods cannot be used to inspect microparts. However, optical measuring systems can be. They provide fast, repeatable measurements without touching the part—a benefit when it comes to small, often-fragile parts.

Optical systems' operation is based on field-of-view technology, which differentiates between dark and light pixels. When inspecting microparts, the highest magnification is used—typically 300×. Accuracy is within microns.

Programming. Writing the CAM program for a microwire EDMing operation can be challenging. Narrow slots and intricate features eliminate the option of simply creating a tool path around the specified geometry and applying standard machine offsets.

Increasing the challenge is that the program must allow for skimming. (Skim passes, which remove anywhere from 0.0001" to 0.001" of stock, are made after roughing passes for the purpose of meeting part accuracy and/or finish requirements.) This sometimes requires programming in offsets and modifying part geometries.

Thin walls also create difficulties. If macroscale EDM practices are applied to a micropart, the workpiece material may disintegrate. Multiple skim passes often must be programmed to EDM thin walls. MicroEDMing pushes a machine's limits. This requires the programmer to know programming code inside and out in order to take advantage of everything the machine offers.

Thin-wall microparts prove difficult to EDM because the walls sometimes disintegrate. Shown are fiber-optic clips with 0.100mm-thick walls. The parts at left required two operations and were rotated 90° in a fixture accurate to within 2µm.

Machine settings. Machine tool manufacturers have developed many power settings for standard wire. That, though, is not the case for microwires. It may take some time to dial in the best settings for a microscale job.

Flushing also can be a concern. Too much flushing and the part may vibrate, resulting in poor size and surface finish. Conversely, too little can degrade the cutting action.

As with machine settings, the microEDMing knowledge base is not as extensive as it is for standard EDMing. This puts more responsibility on the micropart maker to ensure a job is done correctly, on time and profitably. Investing time in fixturing, programming and other upfront procedures greatly increases the odds of success. µ

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