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ShortCuts

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Thin is in when micro wire EDMing

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The basic elements of micro wire EDMing are much the same as those of its macroscale counterpart. The main differences involve the wire diameter and the material from which the wire is made, but other considerations, such as wire tension and spool size, can play important roles.

Wire diameters for conventional EDMing operations range from about 0.013" to 0.006" in diameter. For micro EDMing, wire diameters range from around 0.004" to 0.001" or smaller. Some machines might require a special option for running small-diameter wire, but for most machines, a shop can buy a set of wire guides, put in the small-diameter wire and be in business.

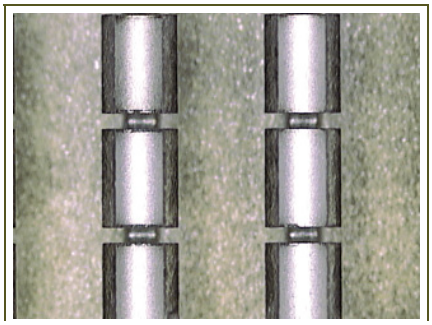
For all wire EDMing, the choice of wire diameter is initially based on the workpiece thickness. All else being equal, the thicker the part, the higher the amperage required to cut it at a certain speed. The larger the wire diameter, the more amperage it can handle, so roughing is usually performed with the largest wire possible. On the other hand, thinner wire carries less amperage and, therefore, cuts more slowly. When very small-diameter wire is involved, productivity can suffer. For example, it is not possible to generate enough amperage with a 0.004"-dia. wire to remove material efficiently on a 4"-thick workpiece.

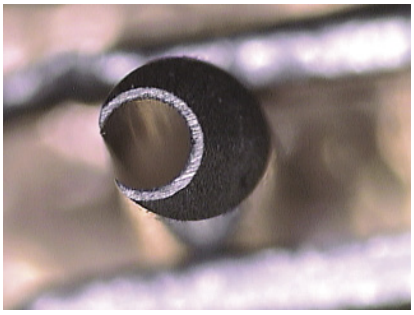
Examples of EDM wire sizes and types from Absolute Machine Tools, including 0.25mm-dia. zinc-coated wire (right), 0.25mm Gamma high-speed wire (left) and 0.25mm brass wire. All images courtesy AccuteX EDM.

Part geometry

Although micro EDMing typically does not involve thick parts, part geometry often plays a role in the wire selected. It is sometimes necessary to rough a part with one size wire, then change to a smaller-diameter wire to generate a small corner radius or feature into which the larger diameter wire won't fit.

Overburn, in which the EDMed cavity is larger than the electrode used to machine it, makes it necessary to use a wire that is smaller in diameter than the desired feature. For example, burning a 0.004"-wide slot requires 0.003"- or 0.002"-dia. wire. Generating small inside corner radii, though, requires wire that is less than twice the maximum allowable radius. In the case of a maximum corner radius of 0.002", for example, the wire diameter should be less than 0.004".





This micro EDMed surgical device has a finish of 0.18um R_a and was machined using AccuteX's micro sparking technology (MST II).

Precise cutting can be achieved by micro EDMing with the proper wire diameter and type. The inner diameter of this part measures 0.02" and it required a ±0.0002" tolerance.

Wire diameter generally has minimal impact on surface finish. The material from which the wire is made, however, does affect cutting speed and, in some cases, surface finish and integrity.

Standard, general-purpose wire is made of plain brass, an alloy of copper and zinc. For high-volume production or to meet requirements for greater precision and a finer surface finish, zinc-coated brass is usually selected.

The zinc coating, which is applied via dipping or plating, provides benefits like those offered by a double boiler used to melt chocolate. Heated directly in a pan on a stove, chocolate tends to burn. If the heat is reduced enough to prevent burning, melting is uneven and takes a long time. A double boiler, however, subjects the chocolate to a steady 212° F temperature, and melts it evenly and smoothly. In the same way, a zinc coating provides uniform insulation for the EDM wire, enabling it to cut faster without burning or breaking. Coated wire is more expensive than uncoated wire, but the improved cutting speeds it permits can more than make up the difference.

When microscale features require wire diameters smaller than 0.004", it usually is necessary to apply wire composed of materials engineered for those situations. Wire 0.001" or thinner is available to produce microscale features. However, when wire is that thin, strength becomes an issue. Accordingly, EDM wire 0.002" in diameter and thinner is often made of pure tungsten or molybdenum, each of which offers greater tensile strength than brass.

This micro EDMed surgical part is used to remove plaque in arteries.

An overlooked factor related to the use of small-diameter wire is the size of the spool on which the wire is provided. Smaller-diameter wire often performs better when delivered from a smaller spool. For example, 0.004"-dia. wire is available on a 3-kg (6.6-lb.) spool. When that size wire is run from a 3-kg spool, it has a tendency to run less consistently than wire on a 1.6-kg spool. The reason is that when a large amount of small-diameter wire is wound on a spool, it has a tendency to overlap. The wire also compacts and compresses; just as water pressure increases with depth, a larger amount of wire increases pressure throughout the roll. Wire supplied on smaller spools is more expensive, but provides the best results.

Avoid tangles

Wire tensioning is another aspect of micro wire EDMing that may be affected by the use of larger spools of wire. To avoid overruns and tangles, a spool of wire is pre-tensioned when mounted on a machine. Without tension, the spool will keep turning when the feed slows or stops, and the loose, uncontrolled wire will cause problems. In a micro application, the pre-tension required to control the momentum of a large spool could break a small-diameter wire.

A final point involves flushing pressure, which is critical in all EDMing operations, but especially so when micro EDMing. The pressure should be the absolute minimum needed to achieve desired cutting speeds. Too high a flushing pressure will cause a small-diameter wire to vibrate, negatively impacting part geometry. When flushing at higher pressures, it may not be possible to put enough tension on a small-diameter wire to assure consistent accuracy without breaking the wire. Flushing pressures for standard EDMs are usually from 1,200g to 2,400g, while, in some micro EDMing situations, correct flushing pressures are 200g to 400g or lower.

The wire EDMing process is highly controlled, producing no cutting forces and achieving tolerances within ±0.0001" while generating surface finish in the range of 0.18µm R_a. As such, it is an excellent manufacturing tool, and, taking note of a few special considerations, it is also an excellent choice for making microscale parts. µ

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