A White Paper From Metal Cutting Corporation

Copper Tungsten Alloy for EDM Electrode Material: A Top Down View

Critical Concern

When choosing Copper Tungsten material porosity, which can cause a bump in the EDM cavity, is of utmost consideration. Because of the disparity in melting points, Copper Tungsten cannot be traditionally alloyed. Instead, a powder metallurgical process binds the composition together into a pre-form, which is then sintered. Sintering causes the material to shrink, occasionally resulting in this common defect. One way to ensure proper quality is to use the Press-Sinter-Infiltrate process, where the powder mixtures is first pressed into a die cavity; the "green" form is then sintered at a high temperature to bond the material; and lastly the material is repressed with a copper slug, which finally infiltrates the composition. This time tested process ultimately eliminates porosity and ensures a quality, high-density preform.

Copper Tungsten Alloy: The Top of Mind Electrode Material fo EDMing Carbides

INTRODUCTION

Graphite has long been the preferred material for the majority of sinker EDM electrode applications due to its exceptional thermal resistivity and manufacturability. Graphite provides fairly good cutting rates, wears less than most metallic electrode materials, and improvements in machine design have made it possible to produce a surface finish on par with Copper. Equally, much of the early resistance—primarily due to the excessive dust that graphite produces—has been successfully resolved by new technologies for controlling it.

But, before graphite there was metal. The good conductivity and structural integrity of many metallic electrode materials popularized them for use in the tube type power supplies and R/C generator circuits of early EDM processing. And today, despite the benefits of graphite, several metallic EDM electrode materials remain top of mind for electrode manufacturers—in particular, Tungsten Copper Alloy. But what unique benefits give it a place across industries?

ABOUT MATERIAL PROPERTIES

In order to understand the value of Tungsten Copper as an electrode material, it is necessary to first define the material properties that make for an ideal sinker EDM electrode.

1. Structural Integrity: Though EDM is often considered a "zero-force" process because mechanical stress, chatter and vibration do not directly affect the electrode, the degree to which the material can withstand the thousands of violent electrical sparks it is subject to, is critical to wear performance, and surface finish accuracy—especially in poor flushing conditions.

2. Conductivity: Because electrical current is responsible for material removal, conductivity of material is crucial to cutting speeds.

3. Thermal Resistivity: EDM is a thermal process; and accordingly the higher the melting point of a material, the better the wear rates.

4. Chemistry: The chemistry of an electrode material, which determines its polarity in relation to the workpiece can greatly affect the efficiency of the EDM process.

METALCUTTING

Contact Us:

89 Commerce Road
Cedar Grove, NJ 07003

800-783-6382 TOLL FREE
973-239-1100 PHONE
973-239-6651 FAX

info@metalcutting.com
www.metalcutting.com

A BRIEF HISTORY

The excellent conductivity of Copper made it one of the first materials used for EDM electrodes. Combined with certain power supply settings, it allows for low wear burning, and is compatible with many advanced polishing circuits. In fact, the structural integrity of Copper structural makes it possible to produce extremely fine surface finishes—even without special circuits. Crucially, structural integrity also makes electrodes highly resistant to DC arcing in poor flushing environments. However, pure Copper can be difficult to manufacture as it burrs easily, is difficult to de-burr, and it tends to become gummy when ground or machined. As a result, Copper is only commonly used in very specialized high-speed, small hole drilling applications for carbide or aerospace alloys.

Unlike Copper, Tungsten has relatively low conductivity, which in pure form makes for slow cut rates. However, Tungsten also has a density equivalent to gold, excellent tensile strength and an the highest melting point of any metal. This combination of mechanical properties produces unbeatable wear rates. Unfortunately, it also makes for difficult machining. As a result, pure form Tungsten is used for only a few specific EDM applications.

BETTER TOGETHER

To resolve the manufacturability and wear issues of pure Copper, it can be alloyed with a variety of more mechanically sound materials. In particular, combining Tungsten with Copper using powder metallurgical processes produces a material possessing the best EDM related properties of both. Generally Copper Tungsten displays decent cutting speeds and excellent wear resistance, and it is typically alloyed at a ratio of 70% W: 30% Cu. However, customized compositions are often available for specific applications, where more Copper will improve cut rates and reduce cost, but at the expense of diminished wear. Conversely, adding more Tungsten will improve corner wear, but ultimately lower cutting stability.

Notably, Tungsten does slow the cut rate of pure Copper by about 50%, but most manufacturers are willing to accept the reduced speed for the largely improved wear rates—especially when intricate definition is required, and particularly when EDMing Carbides, where the material holds up exceptionally well in sharp corners. By comparison, Graphite possesses significantly lower mechanical strength properties, posing serious problems in applications—like Carbide EDMing—where the material must undergo significant macro mechanical force.

As mentioned, both materials are difficult to machine on their own, but as an alloy Copper Tungsten is readily manufactured. The addition of Tungsten to Copper virtually eliminates the burr issues of pure Copper, and conversely the addition of Copper to Tungsten helps reduce tool wear, and overall production cost.

CONCLUSION

While Graphite prevails in the larger landscape of EDM electrode materials, Copper Tungsten holds a steady position as the material of choice for EDMing Carbides—particularly when intricate geometries are a must.

Choosing a Vendor

If high quality Copper Tungsten is fundamental to your EDM electrode process plan, than be sure to choose a vendor with an in-place quality system (to ensure controlled conditions and pure materials) and transparency about their bonding method. Additionally, a good vendor should be able to advise on composition based on your application needs.