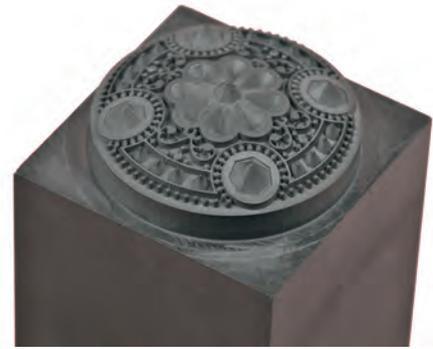
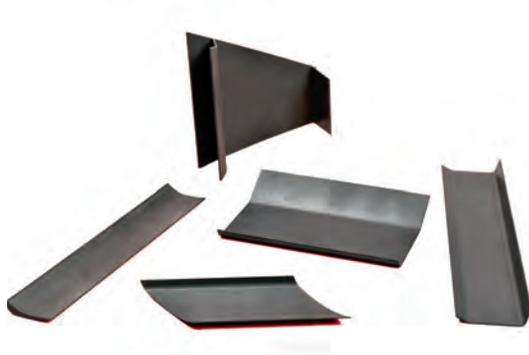


POCO GRAPHITE

An Entegris Company

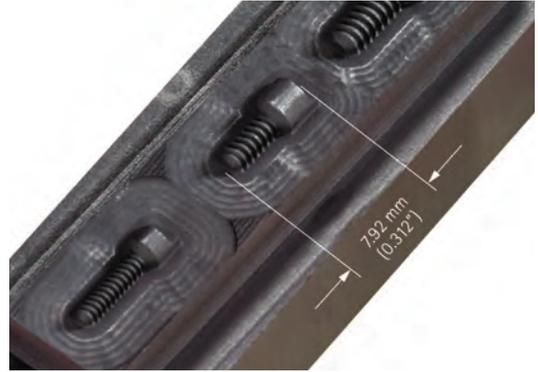
EDM GRAPHITE
SELECTION GUIDE





Aerospace Applications

- Blades
- Vanes
- Seal Slots



Medical Applications

- Surgical Fasteners
- Dental Implants
- Orthodontic Joints



Consumer Applications

- Caps & Closures
- Plastic Injection
- Electrical Connectors

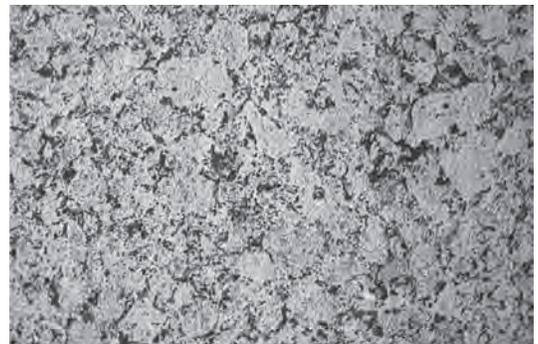


Automotive Applications

- Speakers
- Lenses
- Power Distribution



POCO's 5 micron EDM material



Competitor's 5 micron material

Key Factors of Electrode Selection

EDM has grown up. EDM has taken its place as a proven, precision technology, chosen for what it can do, rather than what conventional machining can't do. EDM machine technology has spawned a world of new applications wherein increased importance is placed on the graphite electrode material utilized.

While there are many methods used to determine the right material for a job, we believe there are five factors that mean the difference between success and failure, profit and loss.

Metal Removal Rate (MRR)

Metal removal rate is usually expressed as cubic millimeters per hour (mm³/hr) or cubic inches per hour (in³/hr), but in fact could just as realistically be expressed as \$/hr. Achieving an efficient MRR is not simply a matter of the right machine settings. It also involves direct energy dissipated in the EDM process. Graphite is generally much more efficient than metallic electrodes, however metal removal rates vary widely between graphite types. With the proper electrode material/work metal/application combination MRR can be maximized.

Wear Resistance (WR)

There are four types of wear: volumetric, corner, end, and side. Of the four, we believe that corner wear is the most important since the contours of the final cut are determined by the electrode's ability to resist the erosion of its corners and edges. It follows that if an electrode can successfully resist erosion at its most vulnerable points, then overall wear will be minimized, and maximum electrode life achieved. Electrode erosion cannot be prevented, but it can be minimized by choosing the proper electrode material/work metal combination and machining at the optimum settings.

The ability of an electrode to produce and maintain detail is directly related to its resistance to wear and its machinability. Minimizing corner wear requires choosing an electrode material that combines high strength with high temperature resistance.

Surface Finish (SF)

Fine surface finish is obtained by a combination of the proper electrode material, good flushing conditions, and the proper power supply settings. High frequency, low power and orbiting produce the best finish, as these conditions produce smaller, less defined craters in the work metal. The final surface finish will be a mirror image of the electrode's surface, so Angstrofine and Ultrafine particle, high strength graphites are the best choices for finishing electrodes.

Machinability

Any machinist who has ever machined graphite is aware that graphite cuts very easily. Simply being easy to machine doesn't necessarily make a material the best choice for an electrode. It must also be strong to resist damage from handling and from the EDM process itself. Strength and small particle size are important so that minimum radii and close tolerances may be achieved. Material hardness is also a factor in graphite machinability, as the harder electrode materials will be more prone to chipping during the machining process.

Material Cost

Electrode material cost generally represents only a small part of the total EDM job cost. What is too often overlooked, however, is that electrode material cost considered outside the total job cost is completely meaningless.

Fabrication time, cutting time, labor, electrode wear - all these factors depend on the electrode material more than on any other factor. Thus it is critical that you know the properties and performance characteristics of the available electrode materials as they affect the work metals you are machining. Only with this data is it possible to make a cost/performance analysis to determine the true cost of an EDM job.

ANGSTROFINE GRAPHITE

EDM-AF5®



POCO's EDM-AF5 is the premier graphite electrode material available on the market today with an average particle size of less than one micron. This particle structure gives EDM-AF5 superior strength, provides for fine surface finish ($7\mu\text{inR}_a$), gives excellent metal removal rate, and high resistance to wear.

Typical Value

Average Particle Size:
<1 μm

Flexural Strength:
14,500 psi (1,019 kg/cm^2)

Compressive Strength:
22,100 psi (1,554 kg/cm^2)

Hardness: 83 Shore

Electrical Resistivity:
850 $\mu\Omega\text{in}$ (21.6 $\mu\Omega\text{m}$)

Applications

- Fine detailed electrodes for engraving
- Hard to machine detail
- Delicate and fragile electrodes
- Various type threading electrodes
- Jobs requiring fine surface finishes
- Intricate molds and dies

COPPER ULTRAFINE

EDM-C3®



POCO's EDM-C3 is a high quality graphite infiltrated with copper, recommended where speed, wear, and surface finish are important. Unequalled for fragile electrodes, many EDM'ers choose this grade to compensate for operator inexperience or where poor flushing conditions exists.

Typical Value

Average Particle Size:
<5 μm

Flexural Strength:
20,300 psi (1,427 kg/cm^2)

Compressive Strength:
28,350 psi (1,993 kg/cm^2)

Hardness: 66 Shore

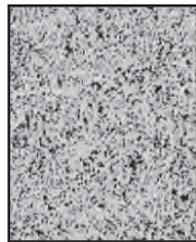
Electrical Resistivity:
127 $\mu\Omega\text{in}$ (3.2 $\mu\Omega\text{m}$)

Applications

- Fine detailed electrodes where strength is critical
- Threading electrodes
- Aerospace applications
- Plastic injection molds
- Machining of carbide
- Small hole drilling

ULTRAFINE GRAPHITE

EDM-4®



POCO's EDM-4 is the premier offering in the Ultrafine grain classification. This highly isotropic grade combines extraordinary strength with moderate hardness, yielding superior electrode fabrication characteristics. EDM-4 has superior EDM performance characteristics for metal removal rates, wear and surface finish.

Typical Value

Average Particle Size:
<4 μm

Flexural Strength:
17,500 psi (1,230 kg/cm^2)

Compressive Strength:
21,500 psi (1,511 kg/cm^2)

Hardness: 76 Shore

Electrical Resistivity:
500 $\mu\Omega\text{in}$ (12.7 $\mu\Omega\text{m}$)

Applications

- EDMing of fine detailed electrodes requiring excellent surface finishes
- Wire cut electrodes
- Plastic injection molds

EDM-3®



POCO's EDM-3 is an isotropic Ultrafine grain graphite which offers high strength with outstanding wear and fine surface finish characteristics easily machined to thicknesses of 0.1mm or less.

Typical Value

Average Particle Size:
<5 μm

Flexural Strength:
13,300 psi (935 kg/cm^2)

Compressive Strength:
18,100 psi (1,273 kg/cm^2)

Hardness: 73 Shore

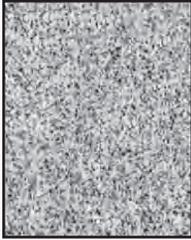
Electrical Resistivity:
615 $\mu\Omega\text{in}$ (15.6 $\mu\Omega\text{m}$)

Applications

- EDMing of fine detailed electrodes
- Punch & die sets
- Plastic injection molds
- Threading electrodes
- Use in aerospace metal cutting

ULTRAFINE GRAPHITE

EDM-2®



POCO's EDM-2 is an isotropic Ultrafine grain graphite with high strength and good wear characteristics. Recommended for use on detailed electrodes, where speed, fine finish and resistance to wear is desired.

Typical Value

Average Particle Size:
<5 microns

Flexural Strength:
11,200 psi (787 kg/cm²)

Compressive Strength:
16,900 psi (1,188 kg/cm²)

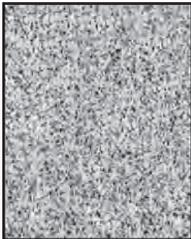
Hardness: 71 Shore

Electrical Resistivity:
620 μΩin (16 μΩm)

Applications

- IC Molds
- Aerospace applications
- Fine-detailed electrodes
- Minimum-taper-cavities
- Blind cavity work

EDM-1®



POCO's EDM-1 is the lowest priced Ultrafine grain graphite available from POCO. In addition to providing good wear resistance, speed, and finish, lower electrode fabrication costs are possible when larger electrodes are required.

Typical Value

Average Particle Size:
<5 μm

Flexural Strength:
9,700 psi (682 kg/cm²)

Compressive Strength:
14,200 psi (998 kg/cm²)

Hardness: 69 Shore

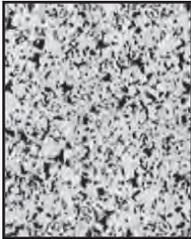
Electrical Resistivity:
760 μΩin (19.3 μΩm)

Applications

- Fabricating electrodes with good detail
- Low wear electrodes
- High detail roughing electrodes
- Molds and dies

SUPERFINE GRAPHITE

EDM-200®



POCO's EDM-200 is an isotropic Superfine particle graphite providing good strength, surface finish, and wear resistance. Moderately priced, EDM-200 provides excellent repeatability from electrode to electrode and from job to job.

Typical Value

Average Particle Size:
10 μm

Flexural Strength:
9,000 psi (635 kg/cm²)

Compressive Strength:
15,500 psi (1,075 kg/cm²)

Hardness: 68 Shore

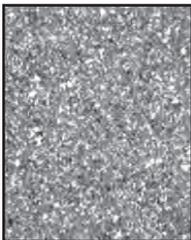
Electrical Resistivity:
580 μΩin (14.7 μΩm)

Applications

- Structural ribs
- Roughing or finishing electrodes
- Large featured mold
- High strength large electrodes

COPPER SUPERFINE

EDM-C200®



POCO's EDM-C200 is a Superfine graphite infiltrated with copper which offers excellent metal removal rates and good wear resistance. EDM-C200 provides improved cutting stability in poor flushing conditions. EDM-C200 is an excellent material for cutting aerospace alloys.

Typical Value

Average Particle Size:
10 μm

Flexural Strength:
12,100 psi (851 kg/cm²)

Compressive Strength:
23,200 psi (1,631 kg/cm²)

Hardness: 62 Shore

Electrical Resistivity:
114 μΩin (2.9 μΩm)

Applications

- EDMing of fine detailed electrodes requiring excellent surface finishes
- Wire cut electrodes
- Plastic injection molds

EDM Graphite Buyers Guide

Graphite Grades

Almost every manufacturer produces a series of grades for EDM applications. Some of the manufacturer grades are sold to EDM end users as the manufacturers' grade. When buying a manufacturer's grade you often have more than one supplier offering the exact grade under the manufacturer's grade name and you also have a known manufacturer in case a concern develops with the material. Knowing the manufacturer and the distributor is a benefit to the customer. A common practice of some manufacturers' is to allow resellers/distributors to rename or house brand their grades. House branding removes the tie to a specific manufacturer and specific manufacturer grade. House branding makes the reseller/distributor a sole source for their house brand. The exact manufacturer's grade may be sold as several other house brand grades, but the end users will not be aware that house brand A from company X is the same as house brand B from company Y, etc.

POCO does not allow our distributors to house brand our materials. When you order a specific POCO grade it must be the same product regardless of the distributor chosen, the region of the world where you buy the graphite, or the length of time between your orders. Electrodes produced from POCO EDM-3 ordered last week will perform just like EDM-3® electrodes that have been in storage at a customer location for 20 years. The manufacturing process must be highly controlled and repeatable to generate consistency within a block, block to block, batch to batch, or decade to decade.

Almost a half century of highly controlled lab analysis indicates there are no grades that are exactly the same. Each manufacturing process yields a product with different physical properties, microstructure and performance. In some cases the physical properties are similar, but the performance as an electrode material varies greatly. In other cases, there may be good EDM performance, but the material is too hard to machine into electrodes. To be a good EDM grade the material must be very consistent, be capable of being machined to fine detail without chipping or wearing tools, and performs well in the EDM process. Excelling in all these areas defines a good EDM material.

In many cases the testing indicates the published specifications are highly exaggerated. For the most part comparing published specifications is of little to no value since there is no policing of the specifications being published. Making buying decisions based solely on published specifications is not recommended.

Guidelines

POCO offers these simple guidelines when purchasing your EDM graphite requirements.

1. Determine the material grade best suited for your application and know why you are selecting that grade. Help in selecting the correct grade for your application is available if you need it.
2. Specify the exact grade you want and note "no substitution" on the quotation request, purchase order, email correspondence, etc.
3. Be on the lookout for words such as "like", "equivalent", or "type" on the quotation, acknowledgement, packing list and invoice. Making it clear that "no substitution is allowed" will help assure that you are getting the exact grade you are ordering and for which you are paying.
4. Know the company supplying your EDM graphite very well. If you are new to EDM, ask other shops what graphite supplier they are using and their experience with the company. If you get a call out of the blue, offering prices too good to be true, beware. There are many companies in the EDM supply business that have developed a very good reputation for honesty, integrity, and ability to service our industry. Select and buy from one of these companies. They will supply you the exact grade you order since their good reputation and livelihood are at stake. These companies will gladly provide a "certification of grade" if requested.

If you have specified the exact grade being ordered, stated "no substitution" on the documents, ordered from a company with a good reputation in the industry and you still would like more assurance that the grade you received is exactly what you ordered, POCO has a solution. We will test a sample of the material at no cost to you. It is not necessary to disclose the grade or the supplier when sending the sample.

We all know that graphite, for the most part, looks the same, feels the same, smells the same and probably tastes the same. However, no two graphite grades are the same in terms of consistency, quality and performance. Being an educated buyer will ensure that you are always getting the exact material needed and ordered.

POCO Technical Articles



Total Cost of Ownership

The Total Cost of Ownership (TCO) model and analysis is commonly used to make decisions when purchasing new equipment, but can also be applied to the major elements associated with the operation of the sinker EDM equipment, such as graphite electrode materials. When TCO principals are applied to these major elements, the value proposition and productivity of these elements start to impact profitability of owning and operating the equipment.

This article provides insight into the key aspects of applying the Total Cost of Ownership Model to your electrode material selection process, and using this method to maximize the efficiency of your EDM process. To access this full article, please scan the QR code.



Dealing with Graphite Dust



Dust, a common household word that can be defined as a finely powdered substance of various matters often suspended in the air. This is no different with the dust generated when machining EDM electrodes. Anyone that has machined graphite knows that the particles generated from the machining process are very fine and have a tendency to remain airborne. However; unlike common household dust, graphite dust has characteristics that must be taken into consideration.

This article reviews these characteristics and hopefully answer often asked questions in dealing with graphite dust. You can access the article by scanning the QR code.



Making EDM Profitable



Review the factors to consider when working with an exotic work metal application, and a real world example of how electrode material selection and EDM parameters can impact the bottom line. To access

this full article, please scan the QR code provided.

EDM Effect on Surface Integrity



Learn about the altered metal layers created during the EDM process, and how the EDM process parameters can impact the work piece finish and surface integrity.

To access to full article, please scan the QR code provided.

Electrode Effect on Quality EDM Finish

This article discusses what impact the electrode material has on producing fine surface finishes economically, even with the newer EDM generator technology. To



access more information about how the quality of your electrode material can impact your work piece finish, scan the QR code to access the full article.

Sometimes Graphite isn't Enough

An explanation of how the correct machine parameters can improve your EDM process when dealing with non-standard materials, such as Beryllium Copper, Titanium and Tungsten Carbide. You can access the full article by scanning the QR code.



Graphite vs. Copper



View a true cost comparison of time and material between Copper and Graphite electrodes and examine the differences between each of the EDM key performance indicators. Scan the QR code

to read the full article and to learn more about Copper versus Graphite.

POCO EDM Reporter

A quarterly news release containing a variety of technical topics, training information, company showcases and upcoming events. Each issue offers pertinent information on items such as graphite properties, electrode manufacturing, EDM operations and how to contact POCO for technical support and applications assistance.

Issue 151: Graphite Machining Tips

What happens when cutting graphite? Does it soften if we get enough energy into the cut? Not really. Graphite dies have certain conditions under which it softens, but these conditions cannot be met under normal atmospheric pressure or oxygen content present in the typical machine shop. The temperature required to "soften" graphite is over 3000° C. At this temperature, the cutting edge of the tool would become ductile and become ineffective in the cut.



POCO Technical Assistance

If you have a question concerning electrode materials (ours or anyone's), pick up the phone and call the EDM experts. POCO's EDM Technical Service personnel have many years of practical EDM experience and can help you with design, machining, operating parameters, or practically any situation involving electrode management techniques.

- Grade Verification
- Production Problems
- Applications Specialists

EDM Technical Manual

The POCO EDM Technical Manual is now available online at www.EDMTechMan.com or as an app for your iOS or Android device.



iOS Device



Android Device

POCO EDM Training

POCO offers an EDM technical training program to help EDMers improve their performance. This is a no-charge, three-day training session that includes classroom and laboratory activities and provides a better understanding of how to control the EDM process to achieve predictable results. This is practical information that the attendee can put to use on the shop floor.



- EDM Basics
- EDM Sinker Technology
- Properties and Characteristics of Graphite

For More Information

Please call your local distributor to learn what POCO can do for you. Visit www.poco.com and select the EDM Distributors for the location nearest you.



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