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A Study of Parameters in Wire Cut Electric Discharge Machining and Profile Cutting Blanks

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***Abstract*: Polycrystalline diamonds (PCDs), because of their excellent wear tolerance, exceptionally high toughness, strong chemical and thermal resilience, decent toughness as well as thermal conductivity, were also used as cutting devices, moulds and diets and equipment. Nevertheless, PCD machining is particularly difficult due to its strong wear intensity and incredibly high hardness. Because PCD binder materials are metals such as cobalt and nickel, the machining of PCDs by electrical discharge machining (EDM) is possible. For this article, EDM was used to break PCD blanks into tiny pieces for the manufacturing of specific PCD cutting devices. The PCD was tested with a 3-D non-contact optical 3D microscope and an electron scanning (SEM) microscope fitted with an energy-sparing X-ray (EDX) spectroscope. The EDM wire cut PCD edge was found to have a broken coating of around 100µm thickness. The PCD binder metal was evaporated by a spark that left several open voids. During the meantime, chemical composition percentages were also adjusted inside the weakened layer near to the wire-cut PCD tip. Both variables will greatly reduce PCD output as a cutting tool. The affected layer should then be fully eliminated by grinding in the manufacture of the PCD device. And cutting efficiency checks are often performed with the industrial PCD equipment to determine the machine existence and comparisons.**

***Keywords*: Wire cut electric discharge, Machining, Profile cutting blanks.**

1. Introduction

Wire Electric Machinery is a metal machining process in which a metal work piece is shot with thousands of sparks onto a metal work piece. Wire EDM deals with materials immune to conventional approaches even because they are electrically conductive; normally non-ferrous, they are constructed of stainless steel, titanium, super iron, brass, etc. It's unorthodox. Instead of cutting, EDM melts or vaporizes the stuff, leaving little waste and a very straight line. A wide variety of EDM devices, which are highly versatile and can cut hard metals and use relatively limited workspace, have been built throughout the entire industry.

A. Wire cut and traditional EDM variations

There are two key EDM forms: conventional and cable. Conventional EDM requires, as described above, a mechanism to disperse the electric current. This unit, the cathode, runs along the metal portion, the anode, and the current reacts to the metal's melting or vaporization. The tiny debris washed the object away owing to the dielectric gas. Wire cut EDM (or WCEDM) discharges the electrified current through a narrow thin wire that is a cathode, guided in the path or kernel needed. A dielectric solution immerses the pipeline, cleans the sparks and directs them. The thin wire permits specific cuts, with keys as wide as three inches and a positioning accuracy of + /- 0.0002. Such increased sensitivity facilitates precise, 3D cuts and creates very clear stitching, die-cuts and strippings.

To order to provide more precision, EDM cables are controlled by CNC systems which can manipulate the wire on a 3-dimensional axis. While conventional EDM does not often yield very complicated corners or designs, the increasing precision of wire EDMs allows complex patterns and cuts. In fact, the EDM wire will break metals up to 0.004 fine. Wire EDM effectively helps the wire to evaporate at any point and thereby eliminate potential waste. The WCEDM wire fires from both ends, which means that the breakage is stronger than the wire itself. Under other terms, when the wire is rounded off with a stream band, the fastest and more precise cutting route becomes feasible with an extra band diameter and cable, and is readily understood by technicians. Manufacturers prefer to manufacture thinner and thinner wires to guarantee much better accuracy and smaller buttons.

B. Systems Wire Cut EDM

For its versatility, EDM wire cutting machines are used by manufacturers for a broad variety of applications. As the machine can cut very tiny pieces, it is also suitable for producing small, highly detailed objects which are normally too delicate for other machine choices. The approach for smaller projects is also cost-effective and may be helpful for making samples even though the real project may require several measures. This should be remembered that the wire is being used and cannot be constantly reused. The expense of steel, brass or other metallic wire would then increase by kilometres. And while the system consumes little resources or creates burrs and should be used with delicate artifacts, the possibility of thermal stress is undoubtedly.

Polycrystalline diamonds (PCDs), because of their excellent wear tolerance, exceptionally high toughness, strong chemical and thermal resilience, decent toughness as well as thermal conductivity, were also used as cutting devices, moulds and diets and equipment. PCD can be translated into very sharp edge and very smooth structure of the device. Such property allows the implementation of high precision and high surface efficiency processing products. PCD cutting instruments have huge benefits over conventional cutting devices such as cemented carbide and high-speed steel machines. High toughness and strong wear resistance enable the application to replace tough materials, such as nonferrous high alloys [1] and composites [2], [3] in the aerospace and automotive industries. The reliability of PCD instruments often takes them to many sectors such as the manufacture of wood products [4], [5].

Several work efforts have been carried out on PCD platform implementations. The equipment for making PCD cutting tools is therefore less implemented. While PCD machining is especially difficult due to its high wear resistance and severe hardness. Since the PCD binder components are metals such as cobalt and nickel, electrical discharge machining (EDM) can potentially be utilized. The electrical machining and grinding processes currently control the development of geometries and cutting edges for the manufacture of PCD tools [6]-[9]. The cutting edge consistency and surface validity of multiple PCD blanks.

Electric discharge grinding (EDG) produced has been investigated [6]. The EDG material removal rate and surface / edge ruggedness were governed by PCD grain size. The PCD machinability of EDM was tested with the ultrasonic transducer vibrated electrode [7]. The performance of EDM has been increased significantly relative to the first EDM without distortion. EDM machinability and PCD hold suppression were also tested in water [8]. Ultrapure water with high resistivity will reduce PCD binder metal 's electrochemical corrosion. Grinding is often widely used in the manufacture of PCD devices. Via laboratory trials of cutting-edge consistency and process output in the grinding of PCD instruments, the diamond wheels for the grinding were optimized [9]. Certain approaches for producing PCD devices, such as abrasive waterjet processing and laser machining [10]-[12], were also investigated. However, these methods are not widely applied in the PCD blanks cutting tool industry due to the high erosion rate of the focussing dust and the costs of abrasive waterjet machining and are not economical in laser machining. The basic studies of manufacturing behaviors and features for wire cutting EDMs of PCD materials are, however, not adequate to lead the industry. This paper would perform an experimental analysis on the EDM wire cutting of PCD blanks to investigate their cutting actions and characteristics. The EDM Wire Cut PCD samples were examined using an optical 3D non-contact microscope (SEM) with an energy scanning ray spectroscope (EDX) and a non-contact electron microscope.

The electric discharge (EDM) process known to us today originated in 1770 with the experiments of Joseph Preistly. He observed that electrical discharges had removed fluid from electrodes in his tests. It is often known to be thermal discharge corrosion.

In the 1940s, the two soviet researchers of the Lazarenkos developed a machining method which formed the basis for modern EDM wire and small EDM hole.

EDM is also referred to as: flame handling, flame eroding and sinking. Illustration of constructive and destructive costs in the edm process.

Why Electrical Discharge Regulation?

The basic electrical discharge system is quite simple. An electric spark is generated between an electrode and a workpiece. The light reveals the growth of electricity. It produces intense heat at 8000-12000 degrees Celsius temperatures and nearly all melts. The fire is controlled and focused very carefully, only impacting the surface of the material. The EDM process normally does not impact the heat therapy under the dirt. The fire also exists in the deionized dielectric vapor. The water conductivity is carefully regulated, rendering the EDM process an excellent setting. The water acts as a refrigerant and flushes the damaged metal pieces free.

Illustration demonstrating how electrical discharge machining erodes a workpiece surface

What is electrical discharge wire machining?

Wire EDM is also known as: EDM wire falls, wire tears, EDM damages, wire melting and wire loss.

Wire discharge machining (WEDM) uses a metal wire for the cutting or molding of a component, usually a leading material, utilizing a tiny electric wire specifically measured. The electrode diameters typically range between 0.004″ and 0.012″, although smaller and greater diameters may be used.

Throughout the wire cutting process, there is no clear contact between the wire and the workpiece that allow to work without distorting the wire path or steel structure. For achieve so, the wire is conveniently wired to a desired voltage. Deionized water is also inside the wire. Once the voltage hits the right level, a funnel jumps over the gap and melts a tiny portion of the job object. The deionized water refreshes and flushes out the microscopic debris.

The part content's durability will not impact the cutting speed. Wire cutting is often used to create extrusion dies and whitening marks.

2. Literature Review

Many attempts have been made since the development of the WEDM system to improve operation performance and functional reliability. The key to transforming a removal process into a controllable operation is device stability. Demand for high surface accuracy in manufacturing industries is constantly increasing at a relatively fast machining pace. The wire electrode is one of the factors for the overall efficiency of WEDM. Numerous studies have been performed to increase the performance of WEDM wire electrodes. The key emphasis of this chapter is wire based factors to improve WEDM performance. The machining speed of WEDM has been linked to the conductivity of wire and the cryogenic process has proved to be an efficient way of enhancing conductivity and regenerating tension in non-ferrous materials. The literature on cryogenic care is also included in this study. Here is the complete literature review.

A. *WEDM performance characteristics*

Wire wire machining (WEDM) is a process of periodic discharge by means of a working fluid from the wired electrode to the working part. The workpiece and the wire electrode lead to the perfect way to break the workpiece into numerous forms of metal moulds, opening, pointing points, device elements, etc. WEDM is an important process of processing complicated two- and three-dimensional structures of hard-to-machine electrically conductive metals (Pandey 1980). Measurements of WEDM performance require cutting pace, finishing and rock accuracy. The key machining parameters influencing WEDM 's performance are the length of the pulse, the pulse-off cycles, the wire size, the wire voltage. In the past several studies have been conducted to improve performance characteristics, such as cutting level, surface roughness and wear of wires, etc.

Daniels and Philips (1976) discussed the wire process EDM's technological consequences. A mathematical model developed by Scott et al to simulate the removal rate and material surface finish (1991) during the machining of the contents of D2 machine steel in various conditions. Tosun et al. (2003a) studied the impact of various process parameters and concluded that open circuit tension and pulse duration are the most important surface ruggedness parameters. Han et al. (2007) The findings were examined that short pulses and long pulses have the same surface roughness as different rates of elimination, although the pulses are constant per discharge. Quick pulse duration with high maximum value may also improve surface roughness. Reverse polarity also has a significant effect on roughness of the air. In addition, Tosun et al. (2003b) have been researching how increased pulse frequency, open circuit tension and wire speed raises the diameter of the crater and the depth of the crater, whereas decreased dielectric fluid pressure reducts certain variables. Liao et al. (1997a) concluded that the feed and pulse speed affect the removal pace and finishing of the soil. Williams and Rajurkar (1991) reported work on WEDM's surface characteristics machining input parameters. Scott et al. (1991) investigated that the surface finish has been enhanced by increase in discharge strength, pulse period and wire length, but that the resultant dielectric flow rate is adversely reduced. Tarng et al. (1995) use the neural grid system for evaluating optimum surface and cutting rate calculation parameters (phase speed, pulse duration, peak current and average servo reference voltage). Greater pressure produces small craters on the workpiece surface and hence more surface roughness (Rebelo et al., 1998). Liao et co. (2004) has claimed that shallow craters with large diameters boost surface efficiency, so the option of a shorter pulse makes it important that electricity be measured at a lower stage. Han et al. (2007) indicated that SR would increase with short pulse duration coupled with strong peak value. Reverse polarity also has a heavy effect on SR.

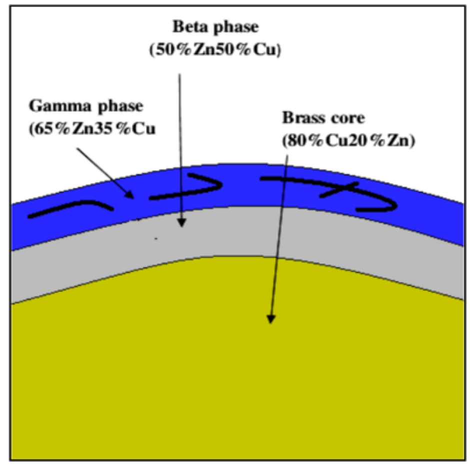

Fig. 1. Gamma-D Wire Electrode (Barthel and Nuser, 2003)

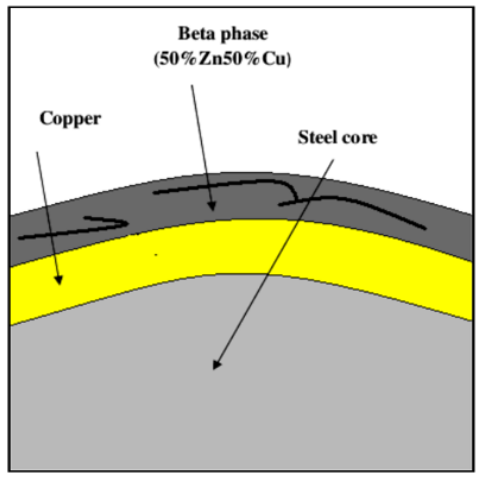

Fig. 2. Composite Wire Electrode (Kern, 2007a)

B. *Composite Wires (Copper Clad Steel Core)*

Composite wires, with a special alloying property of conventional EDM wire electrode (copper, brass), with non-traditional wire (steel), are used in large work parts, interruptible cuts and under fluorescent conditions. Conves et. al. (1981) initially suggested the manufacturing method for copper/zinc coating on a steel core. The steel core allows the wire to maintain its strong mechanical strength and the coating increases its cooling and sprinkling ability. The manufacturing method involves zinc coating by electroplating prior to final wire thickness. In their research, Tominaga et al. (1987) revealed coated wires with a copper coated steel core and a beta coating layer that offers good conductivity and a superior machining precision. The zinc concentration is diminishing radically in the inward direction. These wires give incomparable breakage resistance for large workpieces. Kurth et al. (2004) have unveiled the production, with good reliability, excellent straightness and improved precision, of new copper-coated steel wires, different coverings and core combinations. Some inventors (Blanc et al., 2008; Tomalin, 2007b; Tomalin, 1991) proposed new materials for wire electrodes such as perlitic steel, phosphates and chromates. Pearl steel has been shown to be more effective for cutting with high precision. Harm, high costs and straightness to scrap choppers are the principal limitations due to a steel core. These core steel wires (Fig. 2) are commonly referred to as rivalry, microcutting, macrocutting (Kern, 2007c).

C. Porous Electrode Wire

In its prior art, Tomalin (2007a) disclosed that diffusion of annealed wiring electrodes can be porous and graphite infiltrated to further strengthen their discharge. Continuous coating is retained when the heat-treated wire electrode is coldly drawn. Tomalin (1999) further recognized the potential for a fragile step of the ellipson by annealing a low temperature diffusion to the inclusion of fragile gamma particles on the coating. Wire electrode with porous surface morphology registered an increase in cutting speed up to 15 percent. Increased cuts were also found due to cooling of the wire due to an increase of the surface area. A uniform profile of the outer periphery of porous wire does not affect the accuracy of the work. During EDM, porous nature of the wire would increase flushability and provide room for the removal of WEDM particles. Therefore, a zinc-coated porous cord can be produced without further processes with an increased machining speed and flushability compared to a traditional coated cord. The brass elipson process was defined by Hansen and Anderko (1958) as 84Zn/16Cu. Figure 2.12 reveals an elipson phase layer surface morphology with a coated layer that is compact and smooth.

D. EDM Wire Electrode Shape

Round wire electrodes were used in WEDM for a long time. For other patents too, few other types of wire electrodes were developed (Gonnissen and Vanvooren, 2001). Other than round, the cutting rate and convective heat transfer are improved. Wire surface is increased thanks to shape modifications that promote an improved feed rate due to the heat transfer convection coefficient. Thanks to the sharp edges in flat steel wire which was invented by Dekeyser (1988), spark ignition is improved. There was also an increase in cutting rates attributable to rough wires in WEDM (Schacht, 2004a). In the prior art of Groos (1998), wire electrical discharge was fitted with a drawing die for the wire in various cross sections to improve the operation. An improvement in cutting rate up to 15 to 20 percent was observed by improved heat transfer in six lobed wire electrodes (Inouse,1983). Inouse (1985) patented twisted grooves on a wire electrode in order to avoid sparks at the same level. Zn-coated wires with varying cross sections have been documented in machine ceramic materials by Gonnissen and Vooren (2005). Several inventors (Groos et al., 2004; Seong, 1999) have revealed in their patent that spark generated at WEDM moves near to the wire electrode and hot spots are prevented due to changes in the direction of the wire's rectangular intersection. Figure 4 displays some of the various proprietary wire forms to increase the removal rate of content.

E. EDM Wire Electrode Diameter

Wires of diameter range 0.02mm to 0.36 mm are generally available for WEDM. The cutting rate is enhanced with the development in wire electrodes from copper to composite, etc., not only owing to change in the composition of wire electrode but also owing to increase in the size of wire. For accurate cutting, wires of diameter 0.02mm to 0.100mm are used (Uhlmann and Roehner, 2008). Holye, (2006) reported that wire electrode material has to be matched with workpiece, so that in-process variations are controlled efficiently. He also concluded that 20-30 micron wires are typically used to create small parts with very close tolerances and finished surfaces. High performance larger wire electrode diameters are used for faster cutting as higher energy is applied at the spark point and three to four times the quality premium of the brass wire. The increase in the diameter of the wire is due to an increase in the voltage of the cutting distance (Gedeon, 2001). In 1969, a wire of 0.150 mm diameter was used to achieve the maximum cutting rate possible which subsequently increased to 0.455 mm.

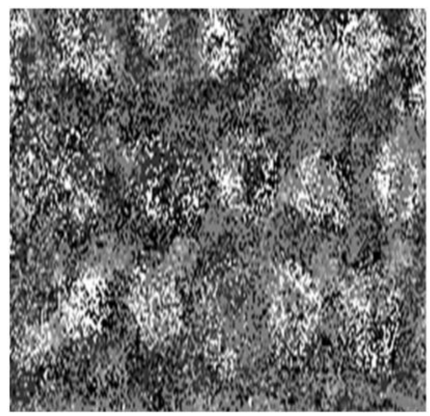

Fig. 3. Surface Morphology of Elipson Phase Coating (Tomalin, 2007a)

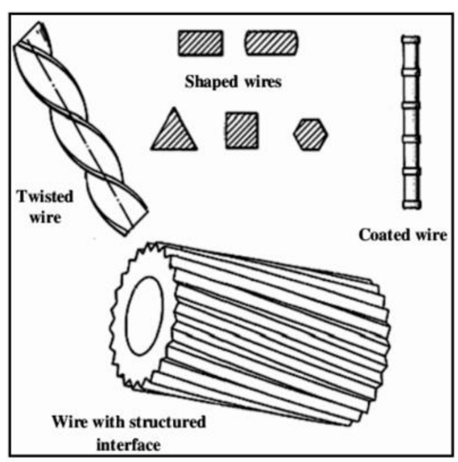

Fig. 4. Customized Wire Shapes
(Groos, 1998; Inouse, 1983, 1985; Seong, 1999)

Fig. 5. shows the growth of wire diameter as wire electrode is formed to improve the WEDM method. Molybdenum and

tungsten wires are commonly used since the metal and copper wires are weak in load. For smaller works in diameter, composite wires (Molycarb) have major advantages (Schacht et al., 2004c). In the past (Herrero et al. 2007), attempts have been made to identify and examine the essential force components of the wire electrode of smaller diameter (0.03 mm), such as electrostatic, electromagnetic, dielectric flushing, wire friction, cable feed, etc. Efforts were also made to build a wire transmission and power supply network for handling fine wires smaller than 80 microns (Uhlmann and Roehner, 2008; Gruber and Kunz, 2004).

F. High performance wire electrode applications

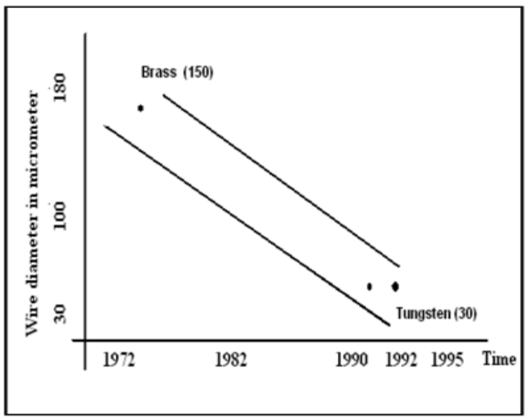

Fig. 5. Higher Cutting Rate Machines

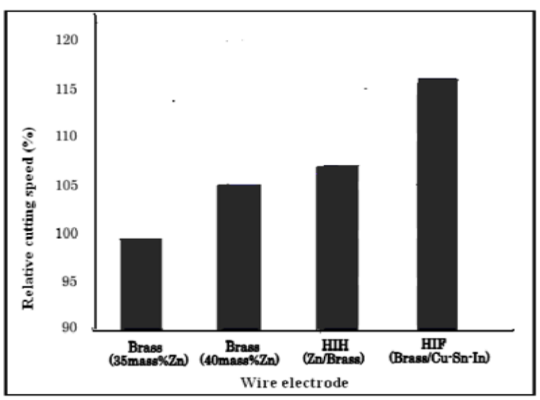

Fig. 6. Characterization of Electrical Using Thick Wires (Schacht, 2004a) Discharge Wire Electrode (Toshiyuki et al., 2005)

Tomalin (1999) proved that composite wire is more durable in surface than the commonly accessible zinc-coated brass wire electrode when machining chromium Molybdenum steel with AISI 4140. In one of Niithe 's latest goals (2011), the wire of pure aluminum protected by copper / Zin or zinc alloy layers is used for cold forming alloys for smooth surfaces without wire electrode breakup. Toshiyuki et al. (2005) investigated the impact of brass-coated steel wire electrodes on the simple machining properties of an extruder SKD 11 workpiece. This has been established that with an improvement in the thickness of the brass coating on the steel wire the corrosion rate has improved. They also discovered that high voltage could be added to secure machining with thick brass coated wire electrodes. Okada et al. (2008) carried out experiments on the same SKD11 material to investigate the effect of optimum thickness of brass layer on micro-steel wire and it was concluded that copper content of 60%-70% in brass layer is effective for higher removal rate. A steel core wire allows high preload on the wire electrode in WEDM, which leads to increased precision as compared to tungsten and molybdenum materials.

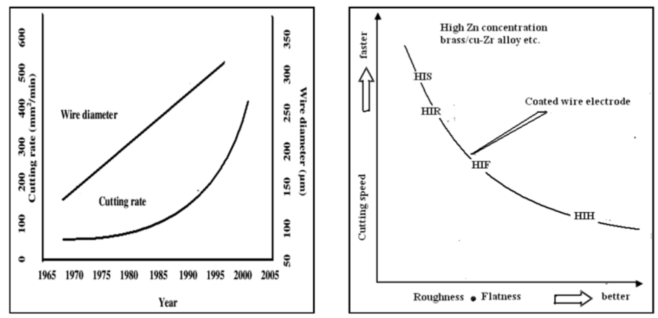

Fig. 7. Wire Diameters for High Precision Applications (Dauw and Albert, 1992)

Experiments (Schacht et al., 2004b) have shown that the skin influence has been a prevailing trend contributing to higher electrical loads and fewer job present. Thicker layers on steel wires overcome the skin effect issue, but thinner wires need no sublack copper to contribute to a good cutting speed. Technologies developed by Aoyama (2001) in the fields of brass wiring in coated wires graded cables: HIH (high hawk), HIF (high falcon), HIE (High Eagle), HIR (high real) and HIS (high sonic). Furthermore, Ayoma et al. (2008) contrasted the existing high-speed EDM (HBZ, HIS, HIR) wire electrodes, used for mass manufacturing applications such as metal moulds for IC lead frames, electronic components. Figure 6, shows various wire electrodes for better roughness and flatness at higher speed. With the flat, painted and composite wire electrodes varying from 0.01 mm to 0.30 mm the design criteria for the configuration of the modules may be satisfied. High pressure, coated wire electrode with a tungsten center, molybdenum or steel has been developed to provide a wire tension required to stabilize the eroding process in the ranges of smaller diameters (0.02 -0.07 mm).

Figure 7 displays the ultra-fine wires in small-pulse intensity and sub-micron geometrical accuracy for micro WEDM applications. In its research Schoth et al. (2005) acknowledged the usage of tungsten microdrills (20-30 µm) for the isolation of ceramics and plastics for medical devices and acknowledged the potential reach of the small wire EDM machines. Titanium and titanium alloys are increasingly used for a broad range of uses in construction, industrial and as surgical implant components. Experimental results were implemented (Antar, 2010; Antar, 2011) to examine the competitive function of aerospace superalloys (Udimet 720 centered on nickel, titanium alloy Ti-6Al-2Sn-4Zr-6Mo) utilizing coated wires (ZnCu50

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and Zn rich brass). In contrast with simple brass wire in the same working circumstances, efficiency improved by up to 70 percent. The volumetric performance of cutting hard to machine materials including titanium alloys (Ti6Al4V) and cemented carbide B40 with uncoated sheet, zinc oxide coated brass, CuZn20 coated sheet, was examined by several author (Kuriakose and Shunmugam, 2004; Poros and Zaborski, 2009). Throughout their experimental research, they found that brass-coated wires could improve volumetric cutting efficiency by up to 50% relative to other wires.

Increased transfer time improves the volumetric cutting capacity. The effect of the central content on WEDM cutting pace is seen in figure 8. The higher cutting rate is the strong zinc content. Cutting performance greatly improves the shielding on commonly utilized aluminum, brass, steel and molybdenum wires through a sheet of content with a limited job feature such as magnesium, alkaline metals and alkaline earth metals (Ho et al. 2004). The impact of cryogenic treated wire electrode in WEDM-machined steel was studied, and smooth surfaces compared with untreated wire electrodes were observed (kapoor et al., 2011b).

G. Cryogenic treatment

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H. Concluding remarks

A literature review found that the bulk of research study was directed at improving the function of the WEDM and modeling the mechanism. According to the limitations on copper wires, the brass wires were made. The brass wire has a weak conductivity limit. The subsequent advances in wire electrodes also culminated in high-performance wire electrodes that result in increased process quality. However, owing to high prices and other environmental threats these wires are seldom utilized. A suitable treatment of metal wire may be a suitable alternative to high-grade wire electrodes to increase WEDM efficiency. Grinding Process. Brazed PCD tool inserts were firstly machined using EDM for roughing to remove extra material, error generated by blank preparation and damaged layer caused by wire-cut EDM. Fine grinding was applied to produce expected tool geometry and cutting edge quality. A 6-Axis CNC Ewag Ewamatic Line cutter grinder was used for brazed PCD tool inserts fine grinding as shown in Fig. 3. Diamond abrasive wheel 6A2 from Ultrawheels was used for the PCD tool inserts fine grinding, which is verified bond D5C125V-400 with a diameter of Ø150x5x8x30x40mm, super fine diamond grit size of 5μm and 125% abrasive concentration.

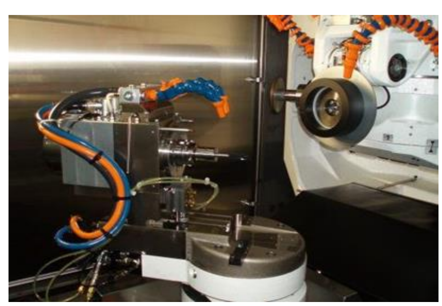
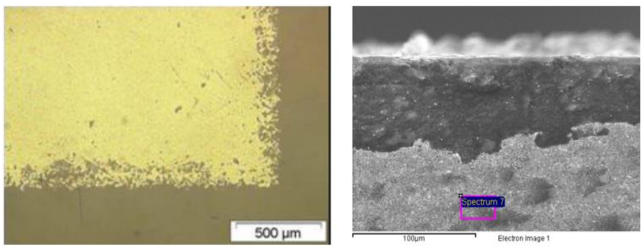


Fig. 8. 6-Axis CNC Ewag Ewamatic Line cutter grinder

3. Results and Discussions

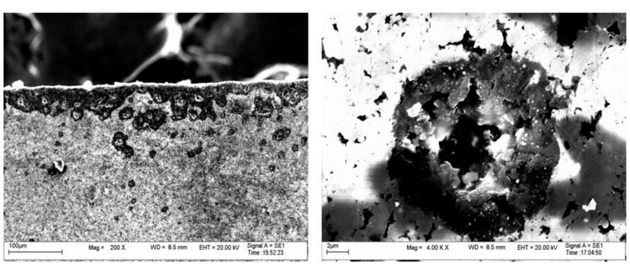
Fig. 4 displays PCD blanks for EDM wire cutting: (a) top and (b) side views. It is obvious that the affected coating displays a foreign color from the substance in the middle of the substrate. The thickness of this compromised coating is roughly 100µm. Due to exceptionally high temperatures during the EDM process, the PCD binding metal was melted and evaporated and the substrate microstructures were also adjusted to alter the material properties. The affected layer must then be fully extracted in the following step.



(a) Top view (b) Side view

Fig. 9. EDM wire-cutting damaged layer of the PCD small pieces

During EDM wire cutting, the presence of water as the dielectric liquid brought electrolysis effects, which dissolves the metal cobalt, bonding material in PCD blanks. Fig. 9 shows the voids generated on the PCD pieces after EDM wire cutting. Diamond particles lost the connection strength and pulled out after the bonding material cobalt dissolved. Fig. 9 (a) shows the overview of PCD small pieces near the EDM wire cutting edge. Some voids were found on PCD small pieces near the cutting edge. Fig. 9 (b) shows the close view of one void under high magnification. The void formed following diamond particles pulled out.



(a) Overview (b) Close view

Fig. 10. Void created by wire cutting EDM at PCD small piece edge

Fig. 10 displays the effects of the PCD chemicals delivery study of the energy-dispersive X-ray spectroscope on the tiny piece of PCD along the EDM wire cutting point. The horizontal axis is the gap (µm) to the EDM wire cutting edge from the analysed point. The atomic contents (percentage) of chemical elements contained in the EDX study are vertical axis. The chemical compositions of PCDs at the edges of the EDM wire are regulated by three main chemical components, such as C, O and Co. Many chemical components, such as Cu, Zn, W, Fe and Al, are negligible owing to the phase of contamination of PCD blank, EDM wire and fixture substrates. The atomic oxygen concentration is significantly decreased from the edge of the EDM wire cutting to the edge of 100µm. Furthermore, under process circumstances, the site impacted region by the EDM wire cutting was estimated to be about 100µm. Throughout the following step, it must be extracted to ensure the tool efficiency. Otherwise, the edge chipping would potentially occur.

4. Conclusion

EDM wire cutting behaviors and properties for custom-made PCD cutting devices have been tested on PCD blanks. The EDM PCD was studied with the assistance of an electronic scanning (SEM) optical 3D non-contact profilometer and energy dispersive X-ray (EDX) scan microscope. It was observed that a weakened coating at the EDM wire cutting PCD edge is about 100µm thick. Electrical flickering created a few voids on the blanket evaporated the binder metal of the PCD. During the meanwhile, the percentages of chemical material below the EDM wire-cutting PCD edge are often adjusted inside the affected substrate. These variables will greatly decrease PCD efficiency as a cutting tool. The weakened coating must then be totally eliminated by corresponding EDM and grinding processes in the manufacturing of PCD devices.

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