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The coating technology with the wire electrode

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Abstract

The purpose of this study is to address requests for higher quality and productivity improvement through wire electrode coating technology. A prime example of high quality is the improved life of tungsten carbide. When a tungsten carbide material is cut in water, the cobalt binder starts to dissolve. As a result, the material becomes weak. In this study, we experimentally examine the effect of coating the cutting surface with wire brass. We found that the life of molds could be thereby extended. As an example of productivity improvement, we show a method for core processing automation. When the operator completes a rough cut for all shapes leaving uncut parts, the operator must move the axis manually for each shape in order to finish the uncut part and remove the core. We studied the effect of coating the cutting surface with brass wire in this context, as well. Accordingly, we found that brass could be coated on a part 1 mm from its upper face and could hold the cores. The operator can then cut away the coated part by simply tapping on the cores.

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Keywords: WEDM, Corrosion, Core Processing, High quality of the mold, Productivity improvement

1. INTRODUCTION

Recently, the domestic mold industry has faced low-cost competition, which is unavoidable even in the high-precision field, owing to the rise of overseas mold manufacturers. In order to respond to requests for cost reduction from users, we have conducted development under the following themes:

- improvement in total machining speed through improvement in finish machining speed;
- reduction in operating costs through energy-saving efforts;
- improvement in productivity through automation;
- extension in mold service life through pulse optimization in the domain of finish cutting.

This paper describes part of those efforts.

2. Efforts for mold service life extension

In recent years, the movement to employ cemented carbide, which has excellent wear resistance, for extending mold service life has been spreading increasingly. Expectations for precision machining of intricate shapes with wire electric discharge machining (WEDM) are high as opposed to cutting.

2.1. Corrosion of cemented carbide

On a WEDM machine, which uses water as a machining liquid, a metal workpiece is ionized owing to an oxidation-reduction reaction in water. Part of the ionized workpiece becomes void, causing material defects. With cemented carbide, cobalt, which is the binder, is ionized, resulting in lower strength and shorter mold service life. This is a critical effect for cemented carbide, which is characterized by its high strength and stable physical properties. Fig. 1 shows cracks made by pressing after WEDM.

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Fig1. Pressed condition after WEDM

2.2. Measures against corrosion

While various studies have been conducted recently on the corrosion of cemented carbide, we focused our attention on the ionization tendencies of copper and zinc, which are the main components of brass wire, and we devised a method to coat the surface of a cemented carbide workpiece with brass (hereafter referred to as “EL coating”).

EL coating sets the workpiece side as the cathode and the wire side, which is the machining electrode, as the anode and imposes a bias voltage on the cathode to deposit copper, which has a lower ionization tendency than cobalt, on the workpiece. The deposited copper film prevents the cobalt from ionizing in the water. Fig. 2 shows a model of cobalt leaching out, and Fig. 3 shows a model of EL coating. Fig. 4 shows a model of the EL coating circuit that imposes a bias voltage.

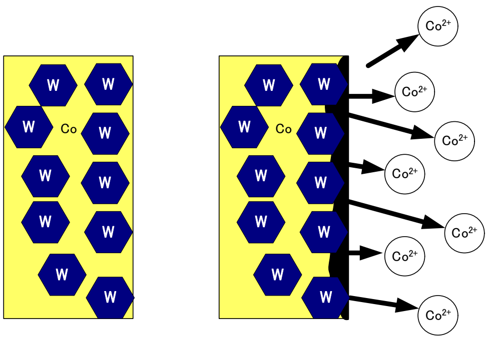

Fig2. Model of cobalt leaching out.

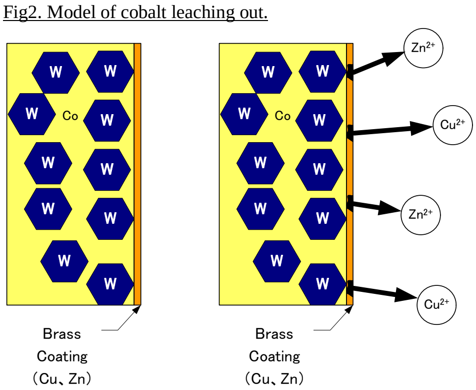

Fig3. Model of EL coating.

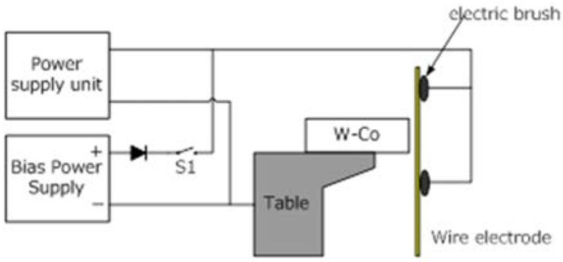

Fig4. EL coating circuit block diagram

2.3. Optimum bias voltage for EL coating

With the workpiece side set as the anode and the machining electrode side as the cathode, we examined changes in corrosion by changing the bias voltage in the range from 10 V to -15 V. Table 1 shows the conditions of experimental cutting.

For evaluation, an 8-mm-square test sample was provided with 5° taper cutting on one side and was provided in the final cutting process with EL coating. With the 8-mm-square test sample left uncut on the workpiece after cutting, a different section of the test sample was continuously machined for 50 h and the condition of corrosion was examined. After the 50-h machining, the tapered surface was grounded with #2000 sand paper, and the boundary was observed under a microscope. Fig. 5 shows the microscopic observation method using the inclined plane grinding method.

Table1.EL coating test conditions

Machine type	M50A
Workpiece	WC (VM-50)
Wire electrode	Ø 0.20 (Brass)
Thickness	20
Cutting count	5 times
Surface roughness	Ra 0.18 μm, Rz 1.5 μm
Resistance	11.82×10^{-4} Ω•cm
Open voltage	10 V, 0 V, -10 V, -15 V
Polarity	Workpiece (+)
Measuring instrument	HiRox KH-3000
Magnification	1400

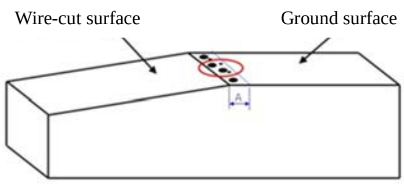

Fig5. Microscopic observation with the inclined plane grinding method

This experiment used a material equivalent to VM-50, which is generally used as a press and is not a corrosion-resistant alloy, in order to facilitate the observation of changes in corrosion. The circled section at the boundary between the wire-cut surface and the ground surface is the corroded section. A test sample machined with ±0 V was also prepared as a reference for corrosion examination. Fig. 6 shows the results of WEDM with bias voltages from +10 V to -15 V.