AF905 - New Cemented Carbide Material for High-Reliability PCB Drills

1. Outline

In recent years, there has been an increase in data processing capacity due to the widespread use of high-performance PCs and automatic driving systems and the communication of high-quality video data by smartphones and other devices. Therefore, printed circuit boards (PCBs) used in these products are required to be more heat resistant and durable than ever before. To improve heat resistance and durability, there has been progress in improvement and increase in the content of heat-resistant and heat-dissipating fillers, super-multilayering of boards, and increase in the thickness of boards, all of which make it more difficult to drill holes in boards. Specifically, it leads to increased drill wear and consequent degradation of hole position accuracy, resulting in decreased board reliability due to degraded hole accuracy and hole inner wall quality.

Therefore, it has been desired to develop a new drill material that achieves high accuracy and high quality for drilling holes in PCBs, which is becoming increasingly difficult.

In response to market demand, we have developed and launched a new material, AF905. AF905 has achieved an unprecedentedly dense structure by controlling the grain size of tungsten carbide (WC), which is the hard phase in cemented carbide, and controlling the thickness of the cobalt (Co) phase, which is the binder phase that exists among the WC grains. Furthermore, by improving the bonding strength of the interface between the WC grains and between the WC grains and the Co phase, we succeeded in significantly reducing the dropout of the WC particles, which causes wear when drilling in PCBs, thereby achieving excellent wear resistance and high hole position accuracy.

Photo 1. PCB drills

2. Features

2-1 Improvement of wear resistance

When drilling holes in heat-resistant PCBs that include many hard glass fibers and ceramic fillers, their ingredients are extremely difficult to cut, which causes the dropout of WC particles as shown in Fig. 1 and results in drill wear. Therefore, in order to achieve high wear resistance, it is important to suppress the dropout of WC particles. In AF905, we have improved the raw materials, additive elements and alloy manufacturing process to control the size of WC grains and the thickness of the Co phase between WC grains, thereby succeeding in achieving dense structures.

By distributing closely packed WC particles with controlled particle size, the contact points between WC particles are increased, and thus even if one WC particle is about to drop out, it is held in place by other WC particles, thereby suppressing the acceleration of wear due to the dropout (Fig. 2). Furthermore, we have improved the bonding strength of the interface between WC grains and the interface between WC grains and the Co phase by improving and controlling the additive elements. As a result, high wear resistance, 1.2 times higher than that of the conventional product, has been achieved in drilling of difficult-to-cut boards.

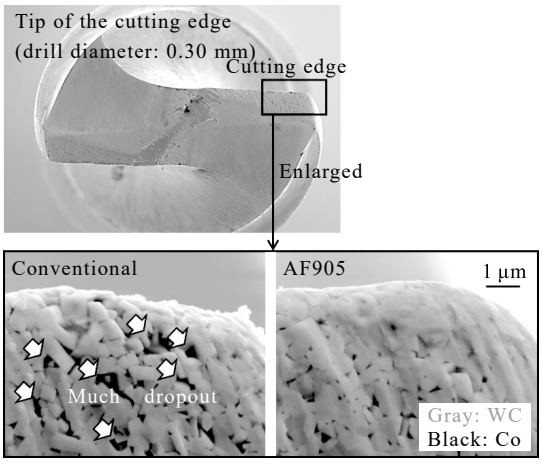

Fig. 1. Photo of the cutting edge after drilling

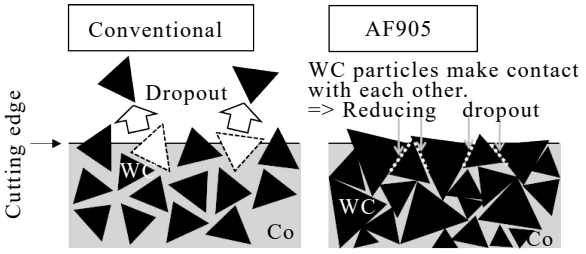

Fig. 2. Concept of the new material

2-2 Improvement of hole position accuracy

Hole position accuracy is important for the operational reliability of PCBs. The hole position accuracy in the initial stage of drilling is correlated with the Young's modulus of cemented carbide that the drill is made of. However, in the case of heat-resistant PCBs, wear progresses significantly due to the dropout of WC particles in cemented carbide, and cutting resistance suddenly becomes high, leading to degradation of hole position accuracy. The AF905 has achieved excellent hole position accuracy (1.2 times higher than that of the conventional product) by improving the Young's modulus compared to that of the conventional product and suppressing wear due to the dropout of WC particles and thereby reducing cutting resistance.

3. Example of Drilling

The following is an example of actual hole drilling of an automotive PCB with high heat resistance under the conditions shown in Table 1.

According to Fig. 3, which shows the amount of wear on the cutting edge (decrease in drill tip diameter) after 4,000 drilling cycles, the AF905 suppressed the wear progression by suppressing the dropout of WC particles, and the wear was reduced by approximately 20% compared to that of the conventional product.

In addition, Fig. 4, which is a diagram indicating the behavior of hole position accuracy in the same drilling process, demonstrates that even after 4,000 drilling cycles, the variation of the hole position from the center of the circle in the AF905 is smaller than that in the conventional product. As an effect of improved Young's modulus and reduced cutting resistance due to the suppression of the dropout of WC particles, the "average +3σ," an index of variation in hole position accuracy, was reduced by approximately 20% compared to that of the conventional product.

The above results support the expectation that the AF905 has excellent wear resistance in the drilling of difficult-to-cut PCBs, whose use is anticipated to expand in the future, resulting in excellent drilling hole position accuracy and hole quality, and demonstrates high reliability in the drilling process of heat-resistant PCBs.

Table 1. Drilling conditions

Drill	Drill diameter	0.30 mm
	Shank diameter	3.175 mm
Work material (PCB)	Board type	For automobiles
	Board thickness x number of stacks	0.8 mm x 4
Drilling conditions	Number of rotations	100 krpm
	Chip load	8.0 μm/rev
	Feed rate	0.8 m/min
	Number of drilling	4,000 hit

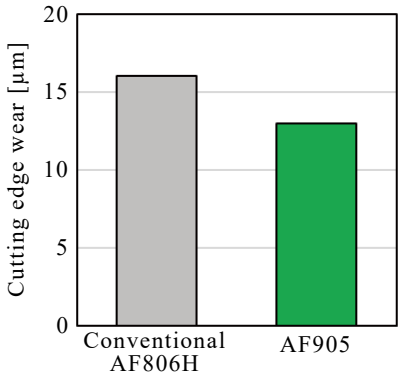

Fig. 3. Wear resistance

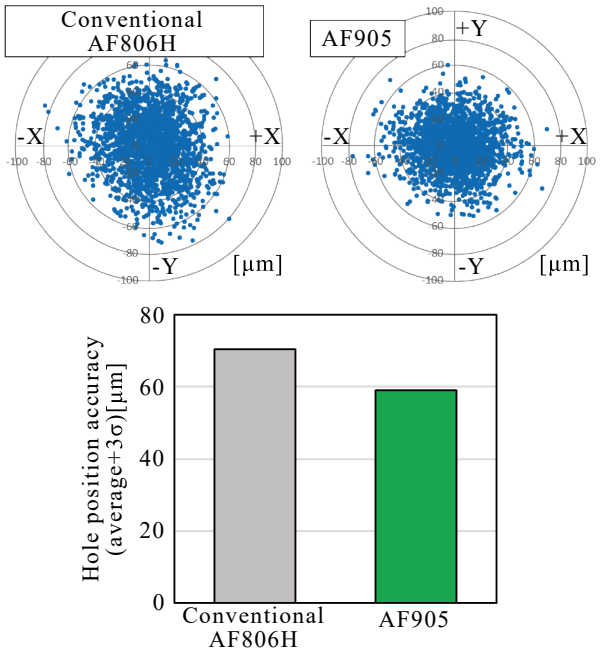

Fig. 4. Hole position accuracy