Wear Characteristic of Titanium -Tungsten- Silicon Based Coated Cutting Tools

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A machine part having a complicated shape can be accurately mass-produced by powder metallurgy, while a sintered material can be produced because it has a large degree of freedom in terms of material design. After the sintering, the sintered material is quenched and tempered in order to enhance the mechanical properties. High-hardened and/or high-strengthened sintered steel is widely used for machine parts because of their high productivity. On the other hand, sintered stainless steel is also used for machine parts where corrosion resistance is necessary, too. For dimensional accuracy, it is often necessary for the sintered steel machine parts to be machined by a mass production metal removal process. The tool life in cutting sintered steel becomes shorter than that in cutting melted steel such as carbon steel. Moreover, as the sintered machine parts are often cut at high cutting speed for the mass-production, the tool materials must have effective wear resistance. There are various methods of surface modification technology designed to ensure good wear-resistance to the surface of a cutting tool material. In surface modification technology, hard materials such as ceramics are coated onto the surface of cutting tool materials. The physical vapor deposition (PVD) method is a form of coating technology widely used because of its lower treatment temperature, namely 470K - 870K.

In cutting, e.g. turning, milling, drilling and tapping, coated cemented carbide tools, which have good fracture toughness and wear resistance, are effective tool materials. TiN and (Ti, Al) N are generally used for the coating film. As machine parts are often cut at high cutting speed for mass-production, tool materials need to have good wear resistance. Furthermore, the tool material must have excellent fracture toughness and wear-resistance. A titanium-tungsten based coating film, namely (Ti,W) N coating film, which exhibits a superior critical scratch load, has been developed. The titanium-tungsten based coated tool was evaluated through the machining of low carbon steel (AISI 5120H steel), and showed greatly improved performance. However, the hardness of (Ti,W) N coating film was lower than that of (Ti,Al) N coating film, hence titanium-tungsten-silicon based coating films have been developed. It was reported that in cutting JIS SCr420H (AISI 5120H) steel with various coated cemented carbide tools, the wear progress of the (Ti,W,Si) N coated cemented carbide tool was the slowest. Therefore, it is clear that the titanium-tungsten-silicon coating is an effective tool material in cutting melted steel. However, the effectiveness of titanium-tungsten-silicon coating film is unclear when cutting sintered steels.

In this study, to clarify the effectiveness of titanium-tungsten-silicon coating film for cutting sintered steels, tool wear was experimentally investigated. Two kinds of sintered steels, namely hardened sintered steel and sintered stainless steel, were turned with a titanium-tungsten-silicon based coated tool according to a PVD method. Moreover, the tool wear of the titanium-tungsten-silicon based coated item was compared with that of the TiN and (Ti,Al) N coated tools.

The main results obtained are as follows:

(1) The critical load of titanium-tungsten-silicon based coating films was higher than that of the TiN, (Ti,Al) N coating film.

(2) The hardness of titanium-tungsten-silicon based coating films was higher than that of the TiN, (Ti,Al) N coating film.

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(3) In cutting sintered steels, the wear progress of titanium-tungsten-silicon-aluminum based coating film tools was slower than that of the TiN, (Ti,Al) N coated tool.

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