PERFORMANCE OF TITANIUM-TUNGSTEN-SILICON-ALUMINUM BASED COATED CUTTING TOOLS

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Introduction

There are various methods of surface modification technology for giving wear-resistance, lower or higher friction coefficient, corrosion-resistance and thermal-resistance to the surface of the material. In surface modification technology, hard materials such as ceramics are coated onto the surface of other materials. The physical vapor deposition (PVD) method is a widely used coating technology 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 as 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 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. So, titanium-tungsten-silicon based coating films, namely (Ti,W,Si)N, (Ti,W,Si)C or (Ti,W,Si)(C,N) coating film, have been developed. These titanium-tungsten-silicon based coating films exhibit both superior critical scratch load and hardness as compared with TiN, (Ti,Al)N coating film. In cutting JIS SCr420H (AISI 5120H) steel, the wear progress of the (Ti,W,Si)N coated cemented carbide tool is the slowest. Therefore, titanium-tungsten-silicon coating is an effective tool material because it has good wear resistance. It was reported that the wear resistance of the coating layer improves by adding Al to Ti-target. Ikeda et al., reported that Al-oxides are generated at the outer surface of the (Ti,Al)N coating layer at a high temperature of about 1100K. Therefore, newly titanium-tungsten-silicon-aluminum based coating films, namely (Ti,W,Si,Al)N, (Ti,W,Si,Al)C or (Ti,W,Si,Al)(C,N) coating film, have been developed.

In this study, in order to determine an effective tool material for cutting low carbon steel, the tool wear was experimentally investigated. Low carbon steel was turned with four kinds of titanium-tungsten-silicon-aluminum based coated cemented carbide tools according to a PVD method.

Conclusions

In order to identify an effective tool material for cutting low carbon steel, tool wear was experimentally investigated.

The main results obtained are as follows:

(1) The critical load of three kinds of Ti-W-Si-Al based coating films was higher than that of the TiN coating film.

(2) The hardness of three kinds of Ti-W-Si-Al based coating films was higher than that of the TiN coating film.

(3) In cutting low carbon steel, the wear progress of three kinds of Ti-W-Si-Al based coating film tools was slower than that of the TiN coated tool.

(4) In the three kinds of Ti-W-Si-Al based coating films, the wear progress of the (Ti,W,Si,Al)N coated tool was the slowest.