Performance of Carbide Cutting Tool Coated DLC and TiAlnto Wear Protection on Cutting Edge

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Abstract

Cutting edge is one of the major factors affecting the tool life of cutting tools. To increase the tool life of cutting tools, keeping the slowest wear of cutting edge must be focused. Hard coating is one of popular wear protection methods on cutting edge, which aims to increase the efficiency of cutting tools, such as increasing cutting speed, resisting tool wear and high thermal, increasing tool life and high quality surface roughness. The main objectives of this work are to present the analysis of influences of the coating materials affecting the surface roughness and wear protection on cutting edge by comparison between the cutting tools coated by DLC and TiAlN. The research found that these of coating materials influence to the surface roughness and wear protection on cutting edge in stainless steel machining.

Keywords : Stainless steel, Tool life, Surface roughness

Introduction

Cutting edge is one of the major factors affecting the tool life of cutting tools[1]. To increase the tool life of cutting tools, keeping the slowest wear of cutting edge must be focused. Hard coating is one of popular wear protection methods on cutting edge, which aims to increase the efficiency of cutting tools, such as increase cutting speed, resistant tool wear and high thermal, increase tool life and high quality surface roughness. This method has been used since the 1960 for increasing tool life of cutting tool[2]. Several research have been conducted to find coatings techniques and coating materials for improving cutting tools in machining process. Biermann, al et[3] investigation of different material coatings CrN, TiN, AlCrN, AlTiN and TiAlNon cabide cutting tool, It was found that the TiAlN and AlCrNwere the most efficient wear resistant. Liew[4] compared carbide cutting tool coated between TiAlN single-layer and TiAlN/AlCr Nnano-multilayer and found that TiAlN/AlCr Nincreased the tool life more thanTiAlN single-layer. Aramcharoen et al[5] represent the different coating material TiN, TiCN, TiAlN, TiAlCrN for increasing wear resistant and improving surface quality in machining hard material. It showed thatthe types of coating materials influence to the wear rate when compared with uncoated materials.

However, the previous research did not compare the performance of carbide cutting tool coated by DLC with TiAlN.The main objectives of this work are to present the analysis of influences of the coating materials affecting to the surface roughness and wear protection on cutting edge by comparison between the cutting tools coated with DLC and TiAlN.

Materials and Methods

Material used was stainless steel grade 304L. Flank end mill carbide having a nominal diameter 10 mm, 4 cutting edges in (Figure 1), and coated with DLC and TiAlN are the properties in (Table 1). Side milling machining by high speed vertical machining centre Haas VM02 and experiment setup in (Figure 2). Cutting conditions were : cutting speed V_c = 120 m min^{-1}; axial depth of cut = 20 mm ; radial depth of cut = 0.2 mm ; feed = 0.05 mm/tooth ; cooling with air.Surface roughness measuring by Mitutoyo SJ210 stylusand tool wear examined by the scanning electron microscope (SEM).

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Table 1 Coating properties

Coating materials	TiAlN	DLC
Film thickness (μm)	2.87	1.12
Hardness (Hv)	2300	3000
Friction	0.45	0.1

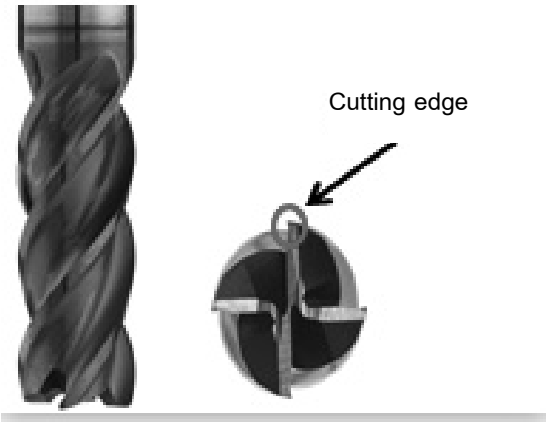

Figure 1 Flank end mill carbide geometry

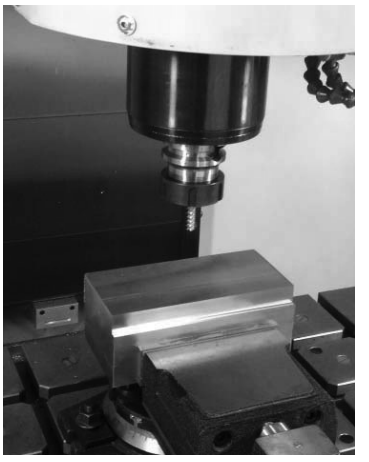

Figure 2 Experiment setup

Results and Discussions

1. Surface roughness

(Figure 3) shows the comparison of surface roughness machining by flank end mill carbide coated with DLC and TiAlN during cutting length 10-50 m. Measuring surface roughness in parallel feed direction by Mitutoyo SJ210 stylus ISO 1997. It can be seen that surface roughness of flank end mill carbide with DLC better than TiAlN and uncoated, due to friction and film thickness properties of DLC was better than TiAlN leading to high performance in machining stainless steel

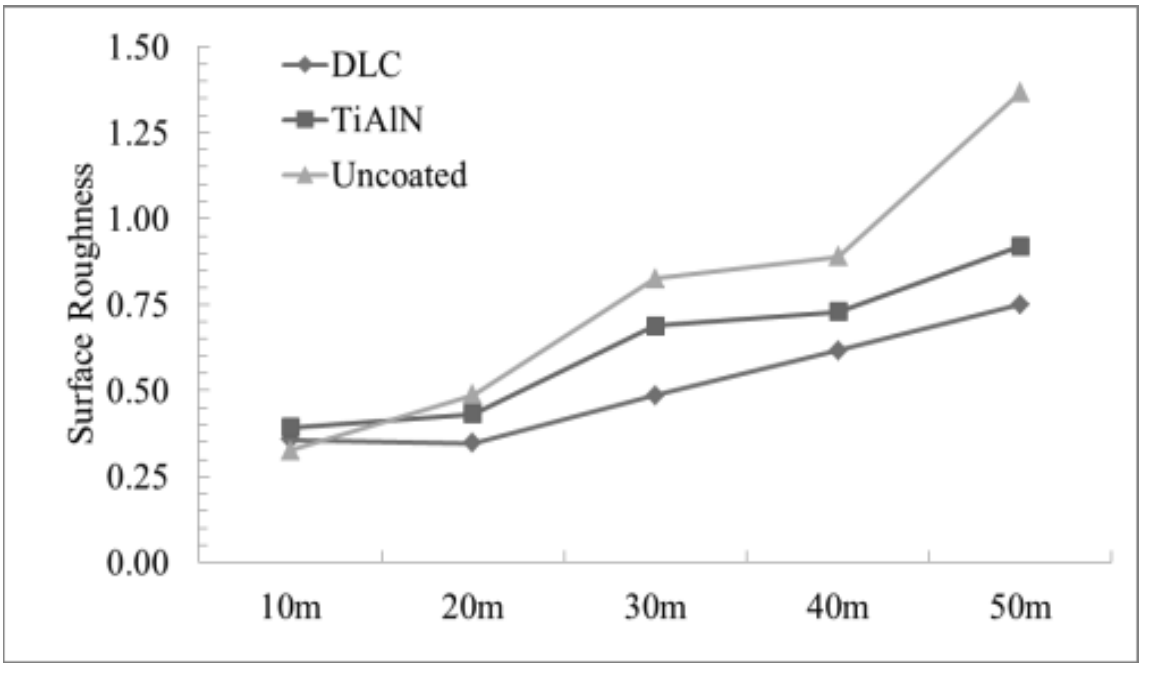

Figure 3 Comparison of surface roughness

2. Tool wear

From (Figure 4) the wear on cutting edge examined by SEM expanding 800x after cutting length 50 m., It was found that the severity of wear was not equal.This indicates that the kind of coating material influence to wear protection on cutting edge. It was also found that the chipping on cutting edge of uncoated and DLC, has the ability to prevent less chipping than TiAlN, which causes the short tool life. However, it was found the flank wear on flank face, but it has less intensity. Due to good adhesion properties of TiAlN[3-7] which leading to increase tool life. Therefore, the TiAlN can perform the wear protection on cutting edge better than DLC and uncoated in the stainless steel machining.

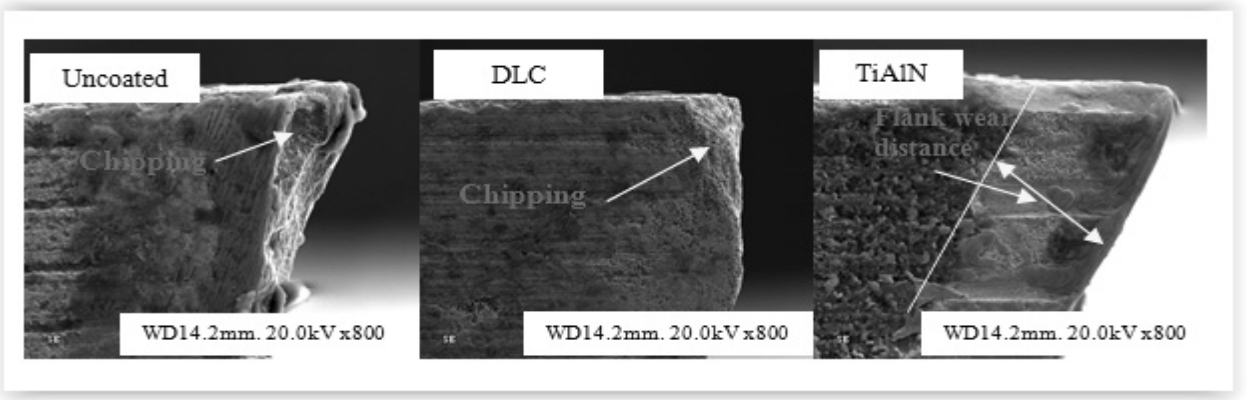

Figure 4 Wear on cutting edge after cutting length 50 m

Conclusion

The comparison of cutting performance off the lank end mill carbide coated with DLC, TiAlN and uncoated onquality of surface roughness and wear protection on cutting edge.The following results are obtained.

1. Types of coating materials influence to the surface roughness and wear protection on cutting edge in stainless steel machining.
2. Flank end mill carbide coated with DLC when machining stainless steel. The surface quality will be better than the TiAlN and uncoated.
3. The TiAlN can perform the wear protection on cutting edge better than DLC and uncoated in the stainless steel machining.

From above summary the DLC-coated cutting tools are suitable for applications required good surface roughness. But the TiAlN-coated are suitable for applications required to increase tool life.

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