QUALITATIVE ASPECTS OF MACHINED SURFACES WHEN TURNING OF ALUMINIUM ALLOYS WITH COATED CUTTING INSERT

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Abstract
The main objective of this experimental scientific study was to examine the effect of the tribological properties of DLC coating on interchangeable inserts on their cutting performance when machining. Completed experiments confirmed the fact that the exchange of the cutting tool used with DLC coating reduces the adhesion of the technological tool-workpiece system and have an impact on the formation and shape of the chips as well as rise-up edge. To analyze the cutting process has been used in several experimental methods such as SEM analysis of wear on the flank VB and rake surface KT of interchangeable cutting inserts. It was also carried out measurements of surface roughness Ra, and cutting resistance using piezoelectric dynamometer Kistler. Examining the shape obtained through debris SEM microscope was as part of completed experiments. It can be assumed that in the case of dry machining of aluminum alloys allow exchange DLC coated cutting tool improved performance of machining.

Keywords: DLC coatings, aluminium alloys, cutting insert, surface roughness, tool wear, cutting forces.

1 Introduction

Engineering industry is increasingly using the DLC coatings for a variety of uses both in medicine and electronics. High quality of cutting conditions and properties of DLC as low wear, high durability are the reasons why we use just the DLC coating. The final started well enough of DLC coating used in the automotive industry for the parts that are most stressed and when they arise largest temperature. In the current production engine of the coating is mainly piston rings, piston pins and valve lifters in a racing car, it is a few more parts. It also had to replace the mechanical engineering as exchange iron for machine tools [1-4]. Hard metals are now slowly but surely replace by the cemented carbides with DLC coatings. The reason is simple such as very low tool wear, high cutting performance, very low surface roughness of the material after DLC coated cutting tool. Progressive growth is mainly focused on machining with the longest tool life of cutting edge, tool surface roughness, higher cutting speeds that are important in mass engineering production. The main objective is the improvement of interchangeable cutting inserts in production process. Economically they are more demanding but at large enterprises into DLC coated cutting tools worth investing in the longer term. The underlying tool is also interchangeable with another series and inserts. DLC coatings are in constant development and improvement and the improvement in coating thickness which has a diameter of 50 microns but more amazingly changed the performance of mechanical engineering in the world. Material of DLC is translated as diamond carbon i.e. carbon hard as a diamond because we know that diamond is the hardest possible material yet. DLC coating may be in various forms such as a-C which is amorphous carbon, a-C:H, hydrogenated amorphous carbon, DLC containing tungsten WC/C or DLC containing iron-Me-DLC. Therefore, the aim of this work was to study the tribological performance of two different types of DLC coatings, thus hydrogenated amorphous carbon and C-H and tetrahedral amorphous carbon ta-C. The basic tribological phenomena affecting performance were investigated tribological tests using different analytical methods. Tribological performance was evaluated in non-lubricated and lubricated sliding conditions. Moreover, adhesion and coating capacity were studied in order to improve the functional properties of coatings in tribological contacts [5-8].

2 Experimental details

Completed experiments were conducted under the following cutting conditions: cutting speed v_c = 300 m.min $^{-1}$, feed f = 0.15 mm.rev^{-1}, depth of cut a_p = 5 mm, width of cut a_e = 5 mm is dry cooling emulsion (5%). For working it used two types of aluminum alloys and 5052 AlCu4.5Si12. Realized experimental measurements of cutting resistance were carried out on 3-component piezoelectric dynamometer Kistler Type 9257. The surface roughness Ra was measured by means of 3D profilometer of type Talysurf CLI 1000. The size and shape of the wear on the back and the face surface has been investigated by SEM microscopy.

3 Achieved results

SEM micrographs of a (Al, Ka) show EDS principal point of the cutting tool after 36 m of dry machining AlCu2.5Si18 alloys are shown in Fig. 4. Adhesion of aluminum alloy does not occur when the test samples with machined cooling. However, the dry machining and the front flank surface non-coated interchangeable cutting inserts unfavorable adhesion of the machined surface, as shown in Fig. 1-4. In addition, cutting edge uncoated cutting tool showed a rise-up edge and the excision of the cutting geometry. Nevertheless, the surface roughness of the DLC coating of the cutting tool is the same as the uncoated cutting tool. DLC coated cutting tool showed no external damage, cutting geometry on the back and fronts. Cutting resistance value is obtained by averaging the values of cutting forces in three cutting edges when machining aluminum alloy AlMg2.5 and AlCu4.5Si12 alloy (can be seen in Figure 5). The main component of tangential force axial component of cutting force and the radial component of cutting force showed lower values for the DLC coated interchangeable plates than for uncoated and during all experiments carried out machining. Especially the main component of cutting force has been reduced to half the rate when machining with DLC coating cutting tool and the initial value of 600 N to 325 N and dry from 538 N to 253 N when machining with cooling. Moreover, the value of cutting resistance at the DLC coated cutting discs with dry machining were lower than in uncoated when machining with cooling. A graphical display of the values obtained arithmetic mean surface roughness Ra was measured in Fig. 6 and Fig. 7 on the bottom surface of the test samples. Surface roughness Ra decreases when machining dry about one half compared with cooling cultivation by using cutting tools with DLC coating. Moreover, the surface roughness of the machining tools with a dry DLC coating as is used in cooling the machining tools uncoated and the two workpiece materials. Cutting performance DLC coating demonstrates just Fig. 8, in which the change in surface roughness Ra for the alloy cutting AlCu4.5Si12 function of the DLC coating of the uncoated cutting tool. Reached the surface roughness after machining approx. 9 m length uncoated cutting tool in the process of the experiment was equal to approx. 72 m length with DLC coating cutting tool.

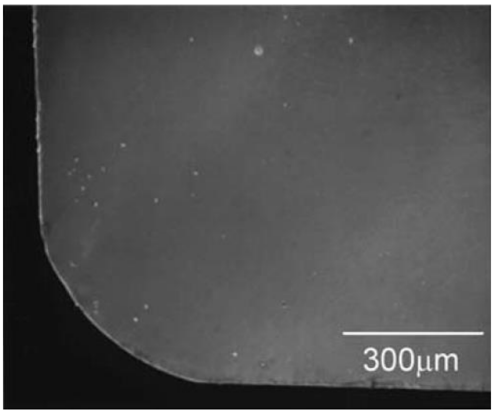

Fig. 1 SEM image of rake face of DLC coated insert

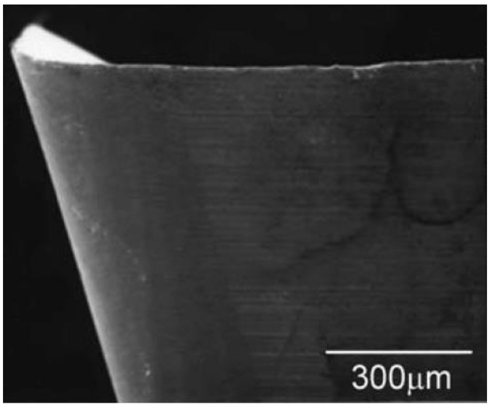

Fig. 2 SEM image of flank face of DLC coated insert

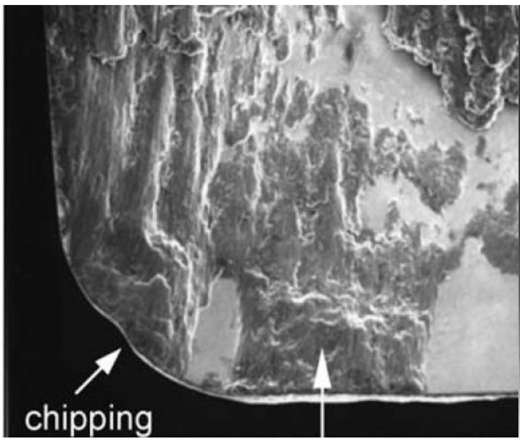

Fig. 3 SEM image of rake face of uncoated insert

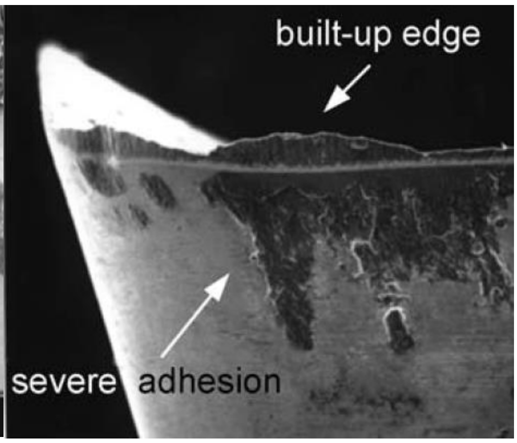

Fig. 4 SEM image of flank face of uncoated insert

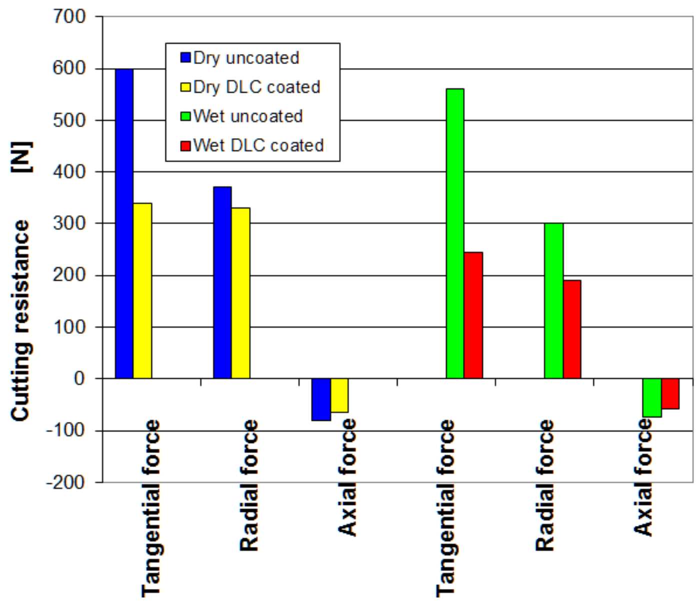

Fig. 5 *Achieved results on cutting resistance*

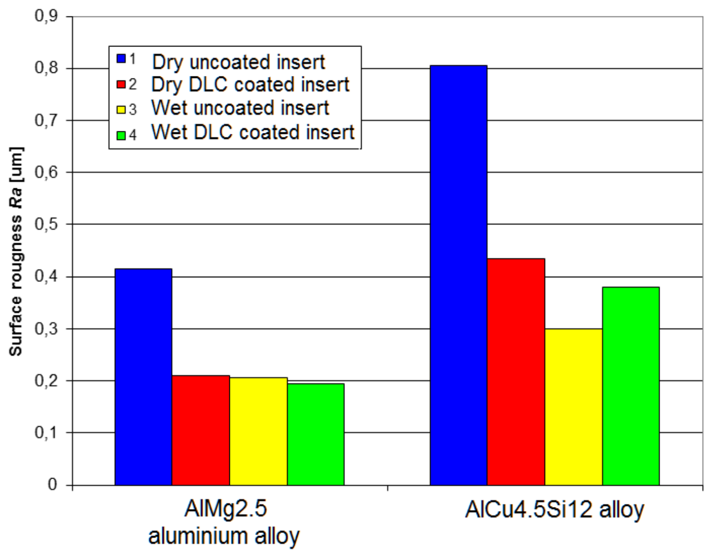

Fig. 6 *Achieved results of surface roughness Ra*

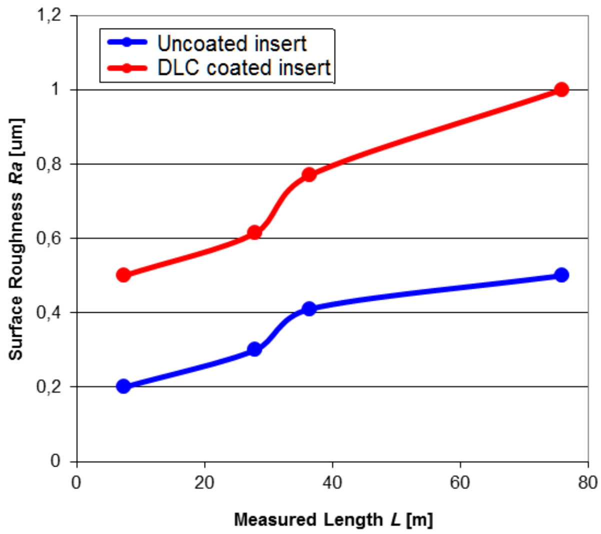

Fig. 7 *Surface roughness Ra as a function of cutting length*

4 Discussion

According to the authors [9-13] can be very phenomenon to explain the process of cutting through the use of shear plane model. According to this model, the deformation zone will also accrue directly to the growth angle head, and conversely reduce the friction process on the front surface of the tool. Chip thickness will diminish with an increase in shear deformation angle. It follows that the degree of chip thickness will diminish. It can also say that cutting resistance will decrease with an increase in the coefficient of friction of the tool. The result would be to improve the machinability said workpiece material. Of realized number of experimental measurements and the use of research methods can be stated that using DLC coated cutting inserts in the machining process was achieved and found a lower coefficient of friction. For this reason also it decreased cutting resistance as will be noted that in Fig. 5. Also making up cutting edge by reducing, it to the preservation of the so-called sharp cutting edge, and thus to improve the machinability and surface finish. Therefore, the life of the obtained DLC coated cutting plates higher than that of non-coated cutting inserts. As with dry machining, and the cooling achieved with the DLC coated cutting tool results in more favorable investigated methods, such as those uncoated.

5 Conclusions

DLC coated cutting tools used with solid carbide have been used in the course of experiments in machining dry and with coolant. Experimental research of authors focused on the process of cutting resistance and wear of the cutting edge geometry. For these experiments we can state the following conclusions:

- DLC coated carbide cutting tools of the dry machining process, achieve lower values of surface roughness Ra (see in Fig. 6), which was due to the low friction coefficient and excellent adhesion properties, and the machining process, also failed to generate build-up edge. As a result of the above cutting edge can maintain its shape and properties (see Figure 1, 2) in contrast to the uncoated cutting inserts (see in Figures. 3, 4). This led to a further decrease tool wear of about 50% and the cutting resistance (see in Fig. 5), thereby to improve machinability.
- When dry machining, the roughness of the surface finish of Ra decreased to about half the value when machining alloy AlMg2.5 and alloy AlCu4.5Si12 by the machining tools with DLC coating. Moreover, the obtained roughness Ra of the cut surface of the DLC coated cutting tools under dry conditions was almost the same as in the cooling of the working with the uncoated cutting tools.

Acknowledgements

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