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WEAR BEHAVIOR OF A CERAMIC TOOL IN THE MACHINING OF THERMORESISTENT ALLOYS

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ABSTRACT

Titanium alloys and stainless steels are used very frequently in the aeronautical industry, materials considered to be of poor machinability. Wear condition has a significant influence on the entire cutting tool wear spread and service life. The present work aims to analyze the wear behavior of a BIDEMICS ceramic tool during the machining of heat resistant alloys. The potential of this cutting tool to machine this type of alloys was demonstrated.

1. INTRODUCTION

Heat-resistant alloys are characterized by poor machinability, causing severe wear to the tool and affecting their useful life. Panigrahi *et al*. (2019) state that tool wear is an important factor to take into account during machining. In the case of machining heat resistant alloys, the main wear mechanisms seen in the tool are: diffusion, adhesion and thermal cracks.

The same way, Tan *et al*. (2018) studied the wear mechanism of two ceramic tools (TB20 and TB80) in the machining of the titanium alloy Ti-6Al-4V. The analysis showed that the dominant wear mechanism was adhesive, while chipping was also observed in TB80. Memarianpour *et al*. (2019) analyzed the behavior of the tool life.

2. MATERIALS AND METHODS

The study was carried out for a turning operation, as a machine tool a HASS-ST 10 CNC lathe was used. Tool wear was measured with the help of a Zeiss EVO MA25 scanning electron microscope. The machining was carried out to a 25 mm diameter bar, made of Ti-6Al-7Nb alloy; and to a bar (25 mm in diameter) of austenitic stainless steel AISI 316L. For the hardness measurement, a Wilson Rockwell Durometer was used. The values obtained were 47.8 HRC for the Ti-6Al-7Nb bars and 149 HB for the AISI 316L steel bars.

The cutting tool used was a "BIDEMICS" RNGN 120700E004 JX1 round insert from the ceramic family, without coating, 12.7 mm in diameter and 7.94 mm thick, specially designed for machining heat resistant alloys. The values of the parameters of the cutting regime used are shown in table 1.

Table 1. Parameters of the cutting regime (LR: Lubrication Rate).

	Vc [m/min]	f [mm/rev]	a [mm]	LR
Ti-6Al-7Nb	130; 200 y 270	0.2	1.0	Dry
AISI 316L	200; 300 y 400	0.1; 0.15 y 0.2	0.5	Dry, MQL

Source: own elaboration.

3. RESULTS AND DISCUSSION

During the dry machining of the Ti-6Al-7Nb alloy, it was observed that the tool undergoes a flaking of material on the attack surface. In addition, abrasive and adhesive wear is observed on the impact and attack surface (Figure 1a).

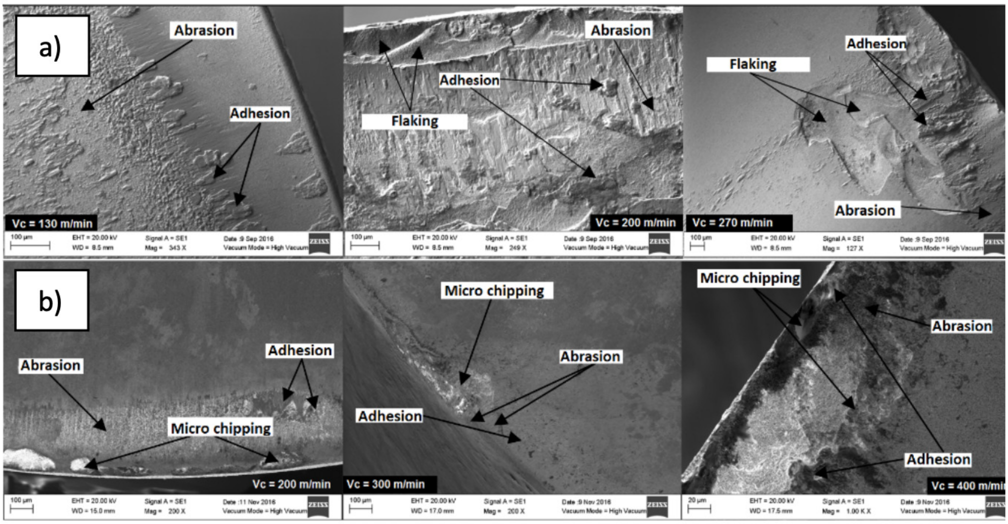

Figure 1. Wear on the attack surface of Ti-6Al-7Nb and AISI 316L.
Source: own elaboration.

These same problems can be seen in the machining of AISI 36L steel (Figure 1b). The chemical composition analysis of the tool (Tables 2 and 3) at various points in the wear zone for the cutting speed of 200 m / min, for both materials, shows that in both cases material detachment appears, abrasive wear and the adhesive (Figure 2).

Table 2. Chemical composition in the wear zone of the rake surface for machining Ti-6Al-7Nb alloy at 200 m / min.

	W %	Ti %	O %	Al %	C %	Nb %	Zr %
P 1	55.54	-	18.85	16.39	5.5	-	3.23
P 2	-	86.12	-	6.64	0.34	7.15	-
P 3	54.92	-	19.36	16.68	5.21	-	3.33

Source: own elaboration.

Table 3. Chemical composition in the wear zone of the rake surface for machining AISI 316L steel at 200 m / min.

	C %	W %	O %	Al %	Zr %	Fe %	Cr %	Ni %	Mn %	Si %	Mo %
P 1	0,02					61,5	18,4	14,8	1,9	0,8	2,1
P 2	5,5	55,2	18,7	16,1	3,3						
P 3	6,1	56,1	17,2	16,6	3,1						

Source: own elaboration.

These predominant wear mechanisms correspond to those obtained in other studies such as those of Tan *et al*. (2018).

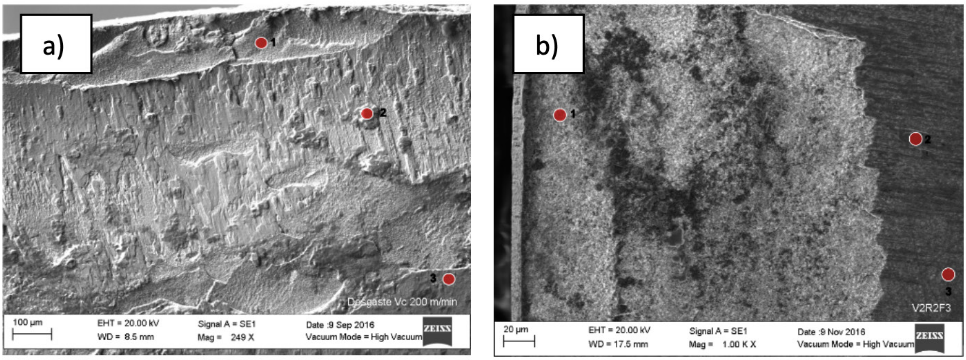

Figure 2. Chemical composition measurement zones in the tool rake surface for a speed of 200 m / min dry. a) Machining of the Ti-6Al-7Nb alloy. b) Machining of AISI 316L steel.
Source: own elaboration.

If it is considered that the cutting speed is the parameter that most affects the wear of the tool, it can be seen that for machining at 200 m / min for both materials, the tool had a better behavior when machining AISI steel 316L.

4. CONCLUSIONS

The highest wear was evidenced for the cutting speed of 270 m / min for the machining of the Ti6Al7Nb alloy and 400 m / min for the machining of AISI 316L steel.

The values obtained are in accordance with that reported in the literature for ceramic tools used under a dry lubrication regime and with MQL. It is observed in the wear pattern, the tendency to the appearance of material detachment on the attack surface of the tool. This pattern is observed for machining both alloys during dry machining. In the case of machining AISI 316L steel with MQL, this detachment is not appreciated.

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