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Methodology to evaluate the tribology of pairs coated CW based tools and Ti6Al4V alloy

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Abstract

This paper suggests a methodology to study the tribology of the titanium alloy TI6Al4V with different coated CW pins. A huge range of pin-on-disc tests were run to establish an accurate method to obtained useful information about friction phenomenon to be considered in forming processes as Single Point Incremental Forming and in the Machining of titanium alloys whereas this friction system is acting in. Combining diverse parameters as sliding speed, normal force and sliding length it is possible to evaluate the evolution of the friction coefficient and the tool wear under different lubricant conditions. In all cases, large length tests allowed more suitable results than short length ones to analyze the tribological behavior of the different tested pairs. Post-test study of the pin surface was developed in order to evaluate the material transfer and the tool wear. In this way, it was possible to link the friction coefficient whit bare CW pins. The use of a lubricant fluid increases the friction coefficient value while reduces the tool wear.

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Keywords: Tribology; COF; tool wear; titanium alloy

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1. Introduction

The Ti6Al4V alloy is widely applied and plays an important role in biomedical and aerospace fields [1-4]. However, machining and forming of the titanium alloys are important problems facing these industries today, due to the intrinsic characteristics of this material and its complex machinability and poor formability [4-8]. It is also known that this titanium alloy owns poor tribological properties [2,8,9], giving rise high friction coefficients and high wear rate. In a sliding process, the surfaces in contact sometimes find the problem of the material that is strongly related to their characteristics and the contact conditions. The surface roughness of the pieces usually causes friction generated between the tool and the chip. In this way, the use of coated inserts has important benefits in the machining processes or forming processes, but not all types of coatings are suitable for every application with titanium alloys. Thus, it is important to take into account the chemical affinity of the tool with the titanium alloy to be processed [10].

Likewise, process temperature and chemical reactivity of the acting materials has a significant influence in the tool wear. In literature there are some authors who have applied different types of PVD coatings to reduce the wear rate of Ti6Al4V alloy [11, 12], but the tribological parameters are not necessarily related to the real machining parameters [13, 14].

In this work, different tests have been designed to develop a suitable methodology for measuring the coefficient of friction, COF, and the tool wear under different tribological conditions. Three CW pins were selected to develop the study. Two of them were covered with diverse PVD commercial coatings (TiN, (Al,Ti)N) and the other one was uncovered. The tribological pairs were carried out under dry and lubricant conditions at room temperature to evaluate the differences on friction and tool wear. Some tests were made in warm condition, 300ºC in order to check the influence of the temperature in the friction process.

2. Methodology and Experimental Procedure

The titanium alloy Ti6Al4V is the metal alloy object of this research. In this way, diverse tribological tests were evaluated to study the wear behaviour between Ti6Al4V sheets and different commercial machining tool inserts. The selected pins were made of three different types of turning inserts, H13A, 1105 and 4025, supplied by Sandvik-Coromant®. The external surface of these CW tools are recovered of (Ti, Al) N_2 and TiN, respectively. Thus, it was necessary to develop a specific pin-holder as it is shown in Figure 1 a.

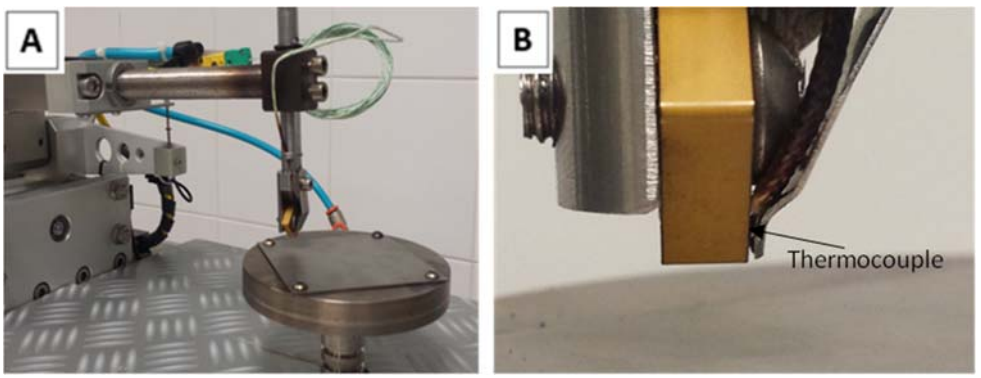

Fig. 1. (a) pin-on-disk tribometer; (b) view of pin-holder.

Tribological tests were carried out in a pin-on-disk tribometer. The experiments were designed taking into account diverse parameters as the normal force (N), the length of the assay (m), the sliding speed (m/min) and the initial temperature of the process (°C). Parameter combinations allowed classifying the experiments in two groups, long distance tests and short distance tests. Nevertheless, the main factor which stablished the difference between both was the length of the assay. Thus, long tests included experiments with lengths around 500m or 1000m whereas short ones were related to lengths lower than 20m.