Tribological behavior and cutting performance of a NbC-Ni-WC-TiC cermet

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The addition of WC and TiC in a nickel bonded NbC cermet was investigated regarding the tribological behavior under dry oscillating sliding at different relative humidities φ and the cutting performance in dry cylindrical turning of C45E at different cutting speeds. NbC-12Ni-12WC-14TiC shows similar coefficient of friction *f* and wear rate compared to NbC-12Ni at φ = 2 %, but no pronounced decrease in *f* with increasing humidity. When turning C45E, NbC-12Ni-12WC-14TiC shows lower material removal V_W compared to other NbC-based cermets, which can be attributed to inhomogeneities in the cutting material and a low hardness.

Keywords: niobium carbide, NbC cermets, tribology, dry cylindrical turning

1. Introduction

Niobium carbide (NbC) is an alternative to conventional cutting materials such as tungsten carbide (WC). Several studies investigated the influence of different metal binders such as cobalt (Co), iron (Fe) and nickel (Ni) and the processing parameters on the microstructure and mechanical properties of NbC-based cermets [1,2]. In contrast to WC-based tools, during dry turning, the potential of NbC-based tools develops with increasing cutting speed v_c through increasing process stability. This study aims to investigate the influence of WC and titanium carbide (TiC) as secondary carbides on the tribological and machining behavior of NbC-12Ni-12WC-14TiC.

2. Methods

A NbC-12Ni-12WC-14TiC (vol%) cermet was produced through powder metallurgy techniques and supplied by BRATS LTDA, Cajamar, Brazil. In order to investigate the binder distribution, SEM-EDX investigations were performed. The tribological behavior was tested under dry oscillating sliding at room temperature and relative humidities of φ = 2, 50 and 98 %. The machining performance of the cermet was evaluated by dry external cylindrical turning of C45E at different cutting speeds.

3. Results

3.1. Tribological behavior

Figure 1 shows the wear rate k_{disk} of the C45E disk versus the coefficient of friction *f* of NbC, NbC-12Ni, NbC-12Ni-12WC-14TiC and WC-6Ni, which served as reference material after 10^6 cycles under dry, normal and moist conditions against a 100Cr6 ball. With increasing humidity, *f* and k_{disk} decrease.

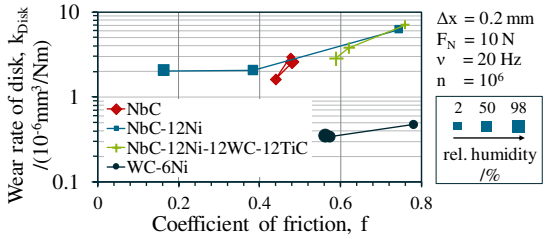

Figure 1: Wear rate k_{disk} versus coefficient of friction *f* under dry, normal and moist conditions against 100Cr6.

3.2. Machining behavior

Figure 2 shows the cutting performance of WC-6Co, (NbC-10TiC)-6Ni-7.5VC, NbC-12Ni-12WC-14TiC and an industrially approved cermet TC60 from Kyocera in machining of C45E. Compared to WC-6Co, which shows a significant decrease in material removal V_w with increasing cutting speed, V_w of NbC-based cutting materials decrease less when high cutting speeds are used.

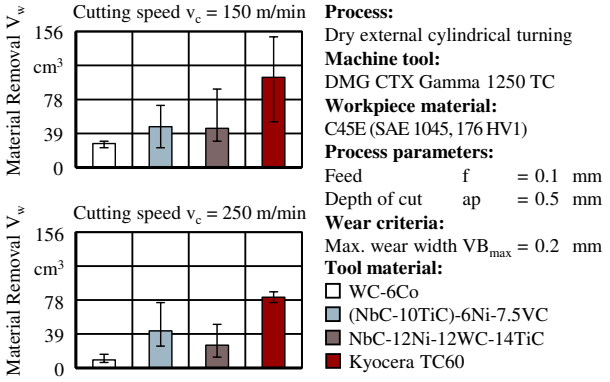

Figure 2: Comparison of material removal V_w of different cutting materials in machining of C45E.

4. Discussion

The microstructure of NbC-12Ni-12WC-14TiC is characterized by a large grain size distribution with grain sizes smaller than d = 5 µm and a homogeneous distribution of Ni binder. It shows no improvement in *f* and k_{disk} compared to NbC and NbC-Ni. In machining of C45E, NbC-12Ni-12WC-14TiC demonstrates less material removal V_W compared to (NbC-10TiC)-6Ni-7.5VC and TC60. These findings can be attributed to inhomogeneities in the cutting material and the low hardness of 1307 ± 37 HV30 in comparison to the other cutting materials. Further results will be reported in the final paper.

5. Acknowledgments

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6. References

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