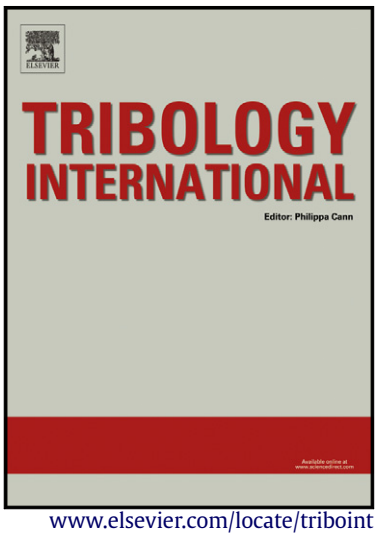

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Effect of cutting conditions on wear performance of cryogenically treated tungsten carbide inserts in dry turning of stainless steel

Nursel Altan Özbek[a], Adem Çiçek[b,*], Mahmut Gülesin[c], Onur Özbek[d]

[a]*Düzce University, Cumayeri Vocational School of Higher Education, Düzce 81700, Turkey*
[b]*YıldırımBeyazıt University, Faculty of Engineering and Natural Sciences, Department of Mechanical Engineering, Ankara 06050, Turkey*
Tel:+903123241555
Fax:+903123241505
E-mail:acicek@ybu.edu.tr
[c]*Gazi University, Faculty of Technology, Department of Manufacturing Engineering, Ankara 06500, Turkey*
[d]*Düzce University, Gümüşova Vocational School of Higher Education, Düzce 81850, Turkey*

Abstract

In this study, the effects of cryogenic treatment on tool wear of uncoated tungsten carbide inserts were investigated in the turning of AISI 316 stainless steel. It was found that notch wear appeared at low and medium cutting speeds, while flank wear and crater wear formed at all combinations of the process parameters selected for turning. In addition, treated inserts exhibited superior wear performance to untreated ones. This can be attributed to high wear resistance and low thermal conductivity of treated inserts. The results were verified by analyses of microstructure and hardness, image processing and X-ray diffraction.

Keywords: Cryogenic treatment, Tungsten carbide, Tool wear, Wear resistance

1.Introduction

The life of tungsten carbide inserts plays a major role in the productivity of machining operations and tooling costs due to the fact that tungsten carbide (WC-Co) is one of the most common cutting tool materials used in industry. Therefore, these inserts are expected to be resistant to the elevated temperatures and forces generated during conventional cutting operations .

The excessive temperatures and forces occur in the machining of stainless steels having hard machinability characteristics due to high Ni and Cr content. This case leads to rapid tool wear and failure of tungsten carbide tools. Cryogenic treatment is a process employed to enhance the life of cutting tools by means of the micro-structural changes that occur during treatment. In cryogenic treatment, samples are subjected to gradual cooling from room temperature to cryogenic temperatures (up to -196 °C), held for a certain period (in general, 24 h), and then gradually heated back to room temperature. Many studies report that some mechanical and physical properties of tool materials such as tool steels and cemented carbides improve with cryogenic treatment. Firouzdor et al. investigated the effects of cryogenic treatment on tool life and wear resistance in drilling of carbon steels with M2 HSS drills at higher speeds. Experimental results showed that tool life of treated and tempered drills substantially improved (up to 126%). Homogeneous distribution of carbides and transformation of retained austenite into martensite were two reasons of improvements in tool life of HSS drills. Çiçek et al