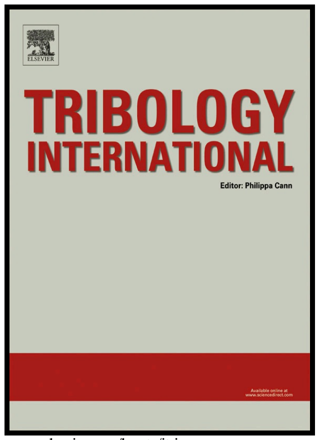
Author's Accepted Manuscript



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S. Sartori, L. Moro, A. Ghiotti, S. Bruschi

PII: S0301-679X(16)30352-8
DOI: http://dx.doi.org/10.1016/j.triboint.2016.09.034
Reference: JTRI4381

To appear in: *Tribiology International*

Received date: 28 June 2016
Revised date: 20 September 2016
Accepted date: 21 September 2016

On the tool wear mechanisms in dry and cryogenic turning Additive Manufactured titanium alloys

S. Sartori*, L. Moro, A. Ghiotti, S. Bruschi

Department of Industrial Engineering, University of Padova, Via Venezia 1, 35131, Padova, Italy
*Corresponding author. Tel.: +39 049 8276819; fax: +39 049 8276816. E-mail address: stefano.sartori@dii.unipd.it

Abstract

Ti6Al4V is commonly considered a difficult-to-cut metal alloy. In order to increase its machinability reducing the cutting temperature, cryogenic cooling with Liquid Nitrogen (LN2) has recently received much attention especially in the biomedical field being non-toxic, safe and clean. This work is aimed at investigating the effectiveness of this cooling strategy in comparison with dry cutting in semi-finishing turning different Ti6Al4V microstructural variants produced by two Additive Manufacturing (AM) techniques, namely Direct Metal Laser Sintering (DMLS) and Electron Beam Melting (EBM). The obtained results prove a correlation between the mechanical and thermal properties of the investigated alloys and the tool wear mechanisms in both dry cutting and cryogenic cooling conditions.

Keywords: Ti6Al4V, Cryogenic machining, Tool wear.

1. Introduction

Titanium alloys are now the most attractive metallic materials for biomedical applications thanks to their high mechanical and corrosion resistance, biological safety, and appropriated tissue response that define the materials bio-functionality. Gepreel et al. [1] and Geethe et al. [2] mentioned the Ti6Al4V titanium alloy as the most appropriate one for the production of long-term prostheses, such as acetabular cups, bone plats and knee joints, since this titanium alloy presents desirable mechanical properties close to those of the bone to be replaced. Usually, biomedical prostheses present very complex shapes that need time-consuming process chains for their manufacturing, including hot forming and machining operations, the latter being characterized by a significant material waste. In the last few years, innovative technologies based on Additive Manufacturing (AM) have been effectively applied to the biomedical field allowing the production of near-net-shape components of complex geometry in small batches, with the advantage of the prosthesis customization on the patient's physical characteristics and the improvement of its bio-functionality thanks to a proper design; the latter characteristic was discussed by Wang et al. [3] who stated that the cellular bio-adhesion process could be modified by the product surface texture. Ti6Al4V prostheses are nowadays manufactured through two distinct AM technologies, Direct Metal Laser