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PII: S0924-0136(18)30092-X
DOI: https://doi.org/10.1016/j.jmatprotec.2018.02.036
Reference: PROTEC 15663

To appear in: *Journal of Materials Processing Technology*

Received date: 16-10-2017
Revised date: 11-1-2018
Accepted date: 23-2-2018

Please cite this article as: Jerez-Mesa R, Travieso-Rodriguez JA, Gomez-Gras G, Lluma-Fuentes J, Development, characterization and test of an ultrasonic vibration-assisted ball burnishing tool, *Journal of Materials Processing Technology* (2010), https://doi.org/10.1016/j.jmatprotec.2018.02.036

Development, characterization and test of an ultrasonic vibration-assisted ball burnishing tool

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ABSTRACT

This paper presents the design and characterization of an ultrasonic vibration-assisted ball burnishing (VABB) tool on Ti-6Al-4V. This process is based on the modification of conventional ball burnishing, by means of the addition of a 40-kHz vibratory force to the burnishing preload exerted by the spring inside the tool. For the purposes of successfully executing the process, a new tool is designed through the assembly of different modules responsible for the various aspects involved in it. That design is hereby presented. Then, a methodology comprising acoustic emission and high frequency sampling is proposed to characterize the functioning of a prototype manufactured according to the previously presented design. The set of techniques deployed to measure the performance of the VABB prototype is presented as a feasible means of characterizing this sort of advanced manufacturing tools, especially like this one which is governed by ultrasonic frequencies. Last of all, the prototype is tested on a Ti-6Al-4V surface to validate it. The superior results of VABB, compared to the non-assisted version of the process, is shown in terms of average and total surface roughness, as well as surface hardness. The highest improvement is achieved by applying the VABB process with 300 N and 5 passes. The effectiveness of the designed prototype is confirmed, and places this kind of VABB tools as inexpensive systems to successfully execute an innovative finishing process for industrial components.

Abbreviations: VABB, vibration-assisted ball burnishing; NVABB, non-vibration-assisted ball burnishing; AE, acoustic emission

Keywords: vibration-assisted ball burnishing; titanium; hardness; roughness; acoustic emission;