
Title: Mirror Surface Machining of High-Alloy Steels by Elliptical Vibration Cutting with Single-Crystalline Diamond Tools

Authors: Hiroshi SAITO, Hongjin JUNG, Eiji SHAMOTO, Tsung-Cho WU, Jui-Ting CHIEN

PII: S0141-6359(17)30075-2
DOI: http://dx.doi.org/doi:10.1016/j.precisioneng.2017.02.008
Reference: PRE 6534

To appear in: *Precision Engineering*

Received date: 25-11-2016
Revised date: 23-1-2017
Accepted date: 2-2-2017

Please cite this article as: SAITO Hiroshi, JUNG Hongjin, SHAMOTO Eiji, WU Tsung-Cho, CHIEN Jui-Ting.Mirror Surface Machining of High-Alloy Steels by Elliptical Vibration Cutting with Single-Crystalline Diamond Tools.*Precision Engineering* http://dx.doi.org/10.1016/j.precisioneng.2017.02.008

# Mirror Surface Machining of High-Alloy Steels by Elliptical Vibration Cutting with Single-Crystalline Diamond Tools

- Influence of Alloy Elements on Diamond Tool Damage -

Hiroshi SAITO[*] Hongjin JUNG[**] Eiji SHAMOTO[**] Tsung-Cho WU[(1)***] Jui-Ting CHIEN[***]

* Yamagata Research Institute of Technology,
2-1 Matsuei 2-chome, Yamagata-shi, Yamagata-ken 990-2473, Japan
Tel: +81-23-644-3222, Fax: +81-23-644-3228
saitohiroshi3@pref.yamagata.jp

** Nagoya University, Furo-cho, Chikusa-ku, Nagoya-shi, Aichi-ken 464-8601, Japan
Tel: +81-52-789-2705, Fax: +81-52-789-5305
jung@upr.mech.nagoya-u.ac.jp, shamoto@mech.nagoya-u.ac.jp

*** Metal Industries Research & Development Centre, 1001 Kaonan highway, Kaohsiung 81160, Taiwan
Tel: +886-7-3513121, Fax: +886-7-3533307
tcwu@mail.mirdc.org.tw, jtc@mail.mirdc.org.tw

**Highlights**:

- Amount of micro-chippings on cutting edge tends to increase with an increase in number of small carbides, difference in hardness between carbides and matrices.
- Chemical states of the alloy elements are analyzed by using XRD analysis and EPMA element mapping to discuss their influence on diamond tool wear.
- Alloy elements of tungsten and vanadium existing in matrices of high-alloy steels can cause the rapid wear of diamond tools
- A practical mirror surface cutting of DC53 with a Rockwell hardness of 62.2 HRC is demonstrated.

Elliptical vibration cutting with single-crystalline diamond tools is applied to mirror surface machining of high-alloy steels such as cold work die steels and high-speed tool steels with a hardness of more than 60 HRC. Although practical mirror surface machining of hardened die steels such as Stavax (modified AISI 420) with a hardness of 53 HRC has been realized with the elliptical vibration cutting, lives of single-crystalline diamond tools are not sufficiently long in machining of some high-alloy steels, that may be caused by a large amount of alloy elements. In order to clarify the influence of the alloy elements on the diamond tool damage, the elliptical vibration cutting experiments are conducted on six kinds of high-alloy steels and four kinds of pure metals which are the same as the alloy elements. Mechanical properties of the alloy steels, i.e. difference in hardness between carbides and matrices, and the number of small carbides, are measured, and their influence on the micro-chippings are investigated. The chemical states of the alloy elements in high-alloy steels are analyzed using an X-ray diffraction (XRD) and an electron probe micro analyzer (EPMA), and their influence on the tool wear is discussed. Based on the investigation, a mirror surface machining of DC53, which has a high hardness of 62.2 HRC and the best machinability in the tested