SURFACE ROUGHNESS INVESTIGATION OF THE CUTTING EDGE OF THE HIGH PRECISION CUTTING TOOLS ENABLED BY MICRO AND NANOMETROLOGICAL MEASUREMENTS

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ABSTRACT

The manufacturing technology of milling, drilling and turning tools have demands of new developing markets as well as quality and lifetime aspects of the machining. In order to achieve the high precision required by machining, the structure and form of the cutting edge of the tools must be investigated to provide the most influential properties. Correlation between the tool wear on the cutting edge regions and surface roughness variation is an important feature to evaluate the state of the tool edge in developing machining process that is possible through nanometrology.

In this study, the high precision measurements compliant with the international standards are carried out to examine the cutting edge of the machining toll samples in both 2D and 3D metrological investigations. The micro and nano scale measurements have been stored in order to creative both qualitative and quantitavie data on edge cross-sections that is known to be the most fluential region for quality and life-time of the machining tools. The results have been discussed and a comprehensive analysis of the cutting edge investigation has been summarized.

Keywords: cutting tool, cutting edge, surface roughness, 2D, 3D, nanometrology

INTRODUCTION

The development of new production tools has been indispensible due to the modern machining industry requirements in both production process and materials. The present trends show that the manufacturing methods and materials demand the need of highest possible productivity level. The combination of the machining tool material compositions, coatings, geometries and present the main investigated topics in this area.

In order to achieve the high precision required by machining, the structure and form of the cutting edge of the tools must be investigated to provide the most influential properties. The developing nano- and micro- precise measurement science have enabled an investigation strategy to integrate into the industrial requirement of flexible, high quality and powerful machining operations [1]. Correlation between the tool wear on the cutting edge regions and surface roughness variation is an important feature to evaluate the state of the tool edge in developing machining process that is possible through nanometrology. Moreover, the material structure change observed in machining process presents the technological data required for development [2].

This study represents the assessment of the surface characteristics and roughness of the end milling tools to establish a nanometrological process management under the guidance of international standards [3]. The advanced metrology methods integrated into the machining industry enable the industry to operate competitively introducing efficiency and savings.

KEY MECHANISMS FOR THE MACHINING INDUSTRY

The process management integrated into an machining industrial company aims to accomplish the following key mechanisms under guidance of ISO 9001 and ISO 14001 [4, 5]:

- Process Quality Control
- Product Quality Control
- Machine and Tool Monitoring
- Organizational Management Control
- Testing
- Waste/Environmental Monitoring
- Efficiency
- Cost Analyze
- Standards&Guidelines Compliance
- Continuous Improvement

With the advent of a management system, the integral aspects of more sophisticated management strategies would be applied competently within the standards in the same organization [6]. It is based on Plan-Do-Check-Act cycle (Deming Cycle) that can be integrated into any kind or size of an organization that has a proven success record with continuous process steps in management systems (Fig.1).

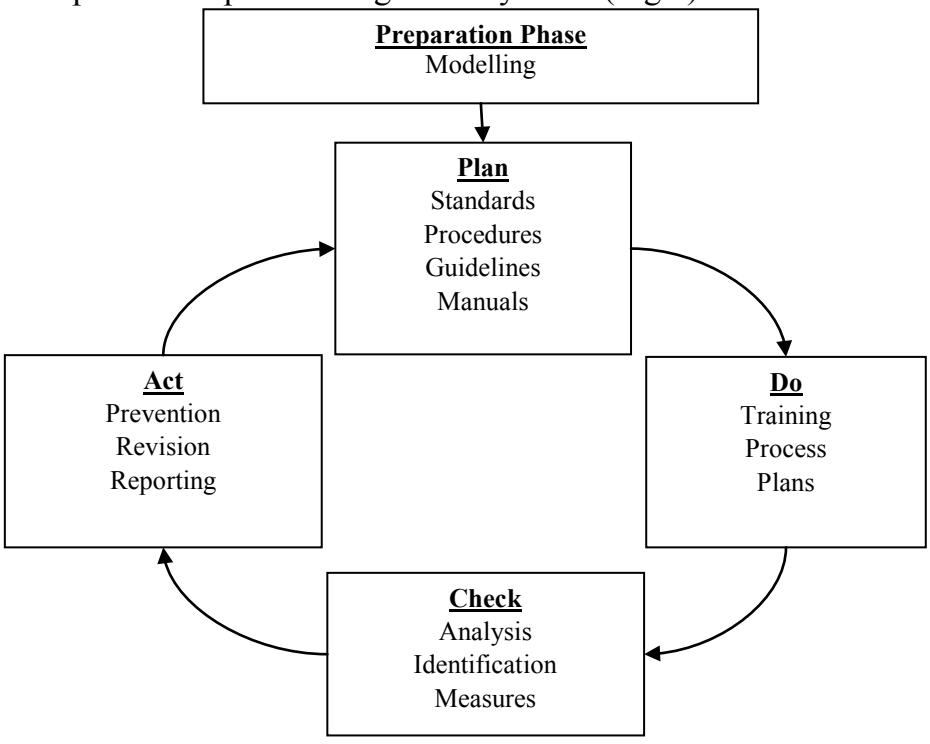

Fig.1
Integration of the Process Management

SURFACE ROUGHNESS INVESTIGATION OF THE CUTTING EDGE

The characterization of the micro- and nanogeometry of the cutting edge of the end milling tools is often challenging due to the experimental precision measurements. In this study, the surface roughness characterization process was carried out by nanometrology devices in order to overcome the challenges by predefined limits in compliant with the international standards.

In this study, surface quality of cutting edges of the selected high precise cylindrical cutting tools was investigated in micro and nano scale. The analyses of the surfaces of the cutting tools were performed for PVD AlTiN coated end mills. The surface investigations consist of two techniques, the contact mode and optical capturing of the magnified images by CCD camera of the laser scanning microscope (LSM), 3D digital microscope (DM) and confocal laser scanning microscope (CLSM).

The measurement results presented are the surface roughness measurements in micro/nano scale by the profilometer [7,8] (Fig.2 and Fig.3) and the capturing of the magnified surface images measuring the micro/nanogeometry of the cutting edge (Fig.4) by the optical digital and scanning microscopes.

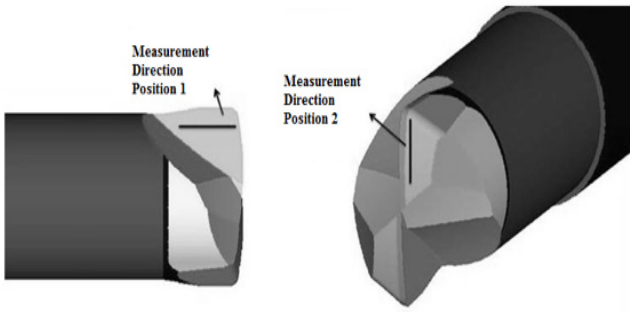

Fig.2
The measurement surface area indication on the end milling tools

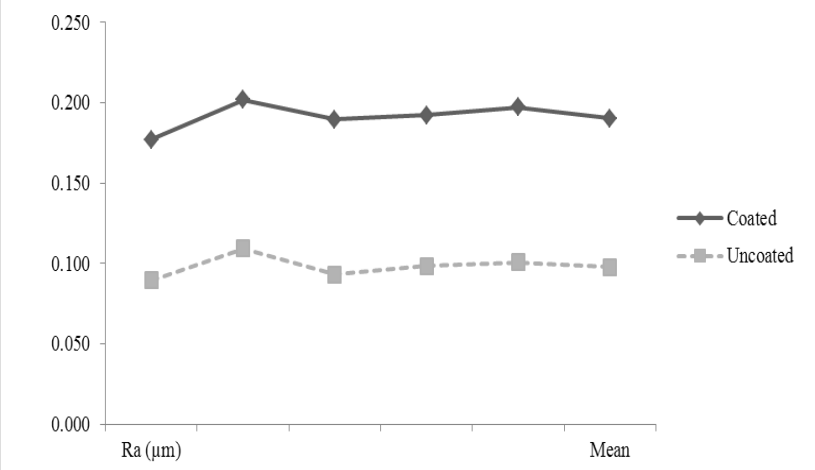

Fig.3
Ra values belonging to the coated and uncoated end mill cutting tool

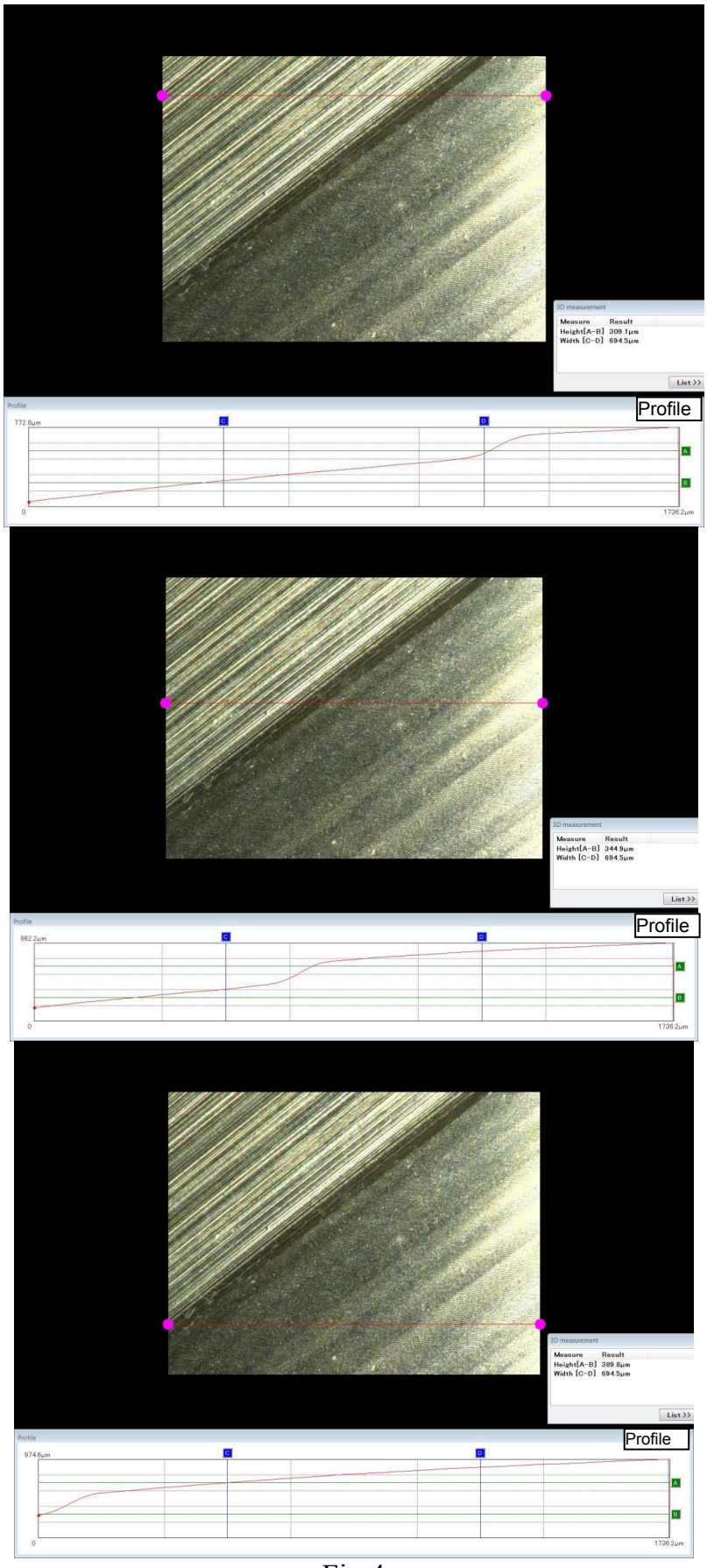

Fig.4
The micro/nanogeometry topographical measurement of the end milling cutting edge using digital microscopy

CONCLUSION

The advanced metrology methods integrated into development of modern milling tools and their industrial implementations are vital to maintain a competitive operation in today's machining industry.

In this study, the high precision measurements compliant with the international standards are carried out to examine the cutting edge of the machining toll samples in both 2D and 3D metrological investigations. The micro and nano scale measurements have been stored in order to creative both qualitative and quantitavie data on edge cross-sections that is known to be the most fluential region for quality and life-time of the machining tools.

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