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TOOL WEAR MEASUREMENT AFTER MILLING OF ALUMINUM ALLOY USING COMBINED ROUGHNESS AND CONTOUR DEVICE

Abstract

During separation of work surface in machining process and transforming it into chips, tool remains in constant contact with the workpiece. During this contact, there are a series of phenomena leading to the tool wear. Tool wear monitoring, and determination of tool life which is a signal to replace the tool with a new one, is important to ensure the continuity of production process in any company where elements are produced by machining. The article presents the results of tool wear measurement after milling of AlSi10Mg aluminum alloy using combined roughness and contour device.

1. INTRODUCTION

During the cutting process in the area of contact between the tool and the workpiece, there are a number of phenomena including elastic and plastic deformation, internal and external friction, a temperature increase, the built-up edge. These phenomena contribute to the wear of the tool. In the era of modern, fully automated machining centres, the tool becomes the weakest link, which constitutes a barrier to automating of the process. At the time of tool wear or damage, the process must be stopped and the tool should be replaced with a new one. The problem is that the new tool does not always have the same dimensions as the previous one. Despite the use of laser or touch probes allowing

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for appropriate positioning of the tool relative to the object it is not always possible to achieve the same position. In many articles [1, 2, 3] the examples of on-line tool wear monitoring systems for controlling the process are widely described. The problem of fast tool wear is particularly evident during machining of hard materials or materials containing hard alloying elements. In such cases the machining parameters are often chosen so that one tool is able to produce one element (one surface - in the case of large components) [4]. Tool wear directly influences the surface roughness, the force in the cutting process, the type and shape of the chips, the properties of the surface layer and the increase of temperature in the cutting zone.

Precise measurement of tool wear indicators is essential to capture the moment tool cutting ability loss. Determination of tool dimensional stability affecting processing errors is important because of the risks of generating objects whose dimensions are not in the required tolerances.

There are a lot of tool wear mechanisms, which may include: mechanical, adhesive, diffusional, thermal and chemical wear. Form of tool wear, which often is examined and analyzed in scientific publications relates to mechanical wear, which in turn can be divided into mechanical abrasion and mechanical strength.

Information concerning the wear tests are contained in ISO 8688-1: 1989 – Tool life testing in milling, which includes information on the following indicators of tool wear on the flank and rake faces. The most frequently discussed indicator of tool wear is flank wear VB, which is defined as loss of tool material from the tool flanks, resulting in the progressive. According to ISO flank wear can be divided into: Uniform flank wear (VB1), Non-uniform wear (VB2) and Localized flank wear (VB3).

Methods of tool wear measuring can be divided into direct and indirect. Indirect methods include measurements of forces, acoustic emission, vibration, surface roughness and temperature. Force measurement as an example of indirect indicator of tool wear is shown at [5]. Whereas, direct methods are related to measurement of tool and geometric changes around the cutting edge. There are two most common varieties of direct methods. The contact method is the first version, which can be carried out directly on the machine, for example, by tool touch probe or laboratory methods with the use of contact device [6, 7]. Combined roughness and contour device is in this group of methods.

The second group consists of non-contact method carried out on the machine e.g. using a laser tool probe or a method based on image analysis using a CCD camera or using scanning electron microscopy, often used for precise measurement of diamond tool wear [8]. These methods allow to create 3D images and on their basis – analyze the tool wear indicators, the examples of which are shown in [9, 10].

The article presents results of tool wear measurement after milling of AlSi10Mg aluminum alloy using combined roughness and contour device.

2. MATERIAL AND EXPERIMENTAL CONDITIONS

The experiment was carried out with the use of cutter after milling of aluminum alloy AlSi10Mg. Hard silicon grains are composed of the alloy, whose share in the composition is 10%, and which may lead to the tool wear. Tests were performed on a Hommel-Etamic RC120 device. View of measuring stand is shown in Fig. 1.

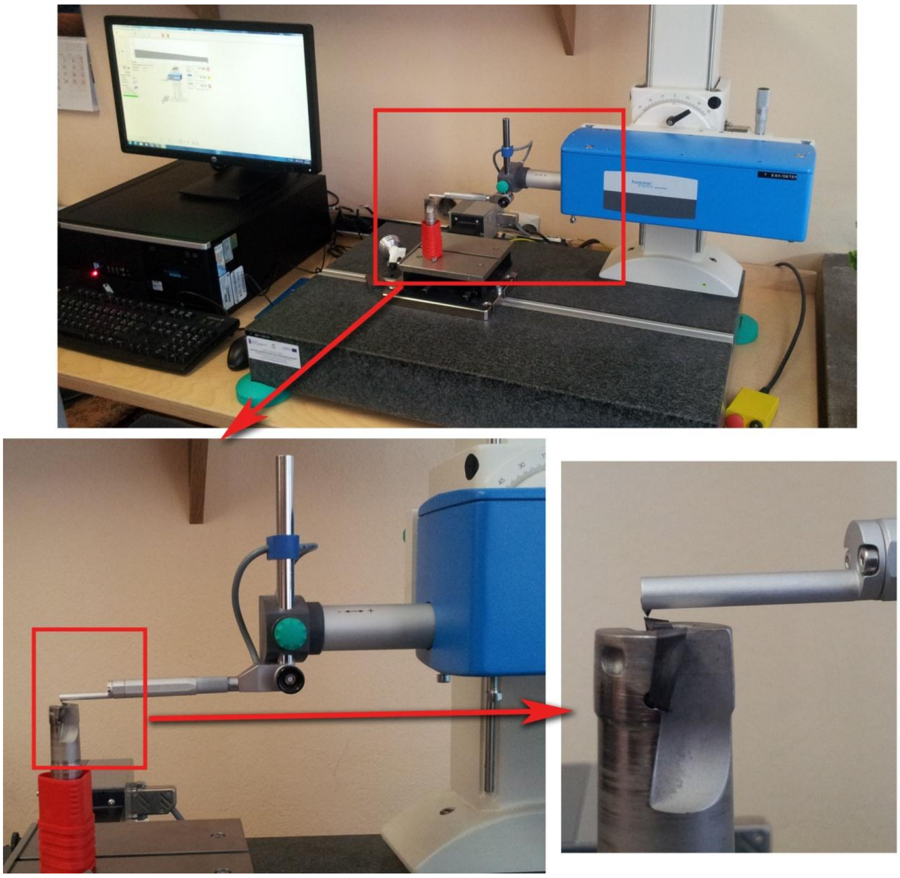

Fig. 1. View of measuring stand [source: own study]

In the studies ISCAR cutter with the diameter of 20 millimeters, with two inserts, dedicated to the machining of lightweight alloys was used. Flank face areas were scanned and contour edge of the cutting inserts was analyzed. Microscopic view of scanned regions are presented in Fig. 2.

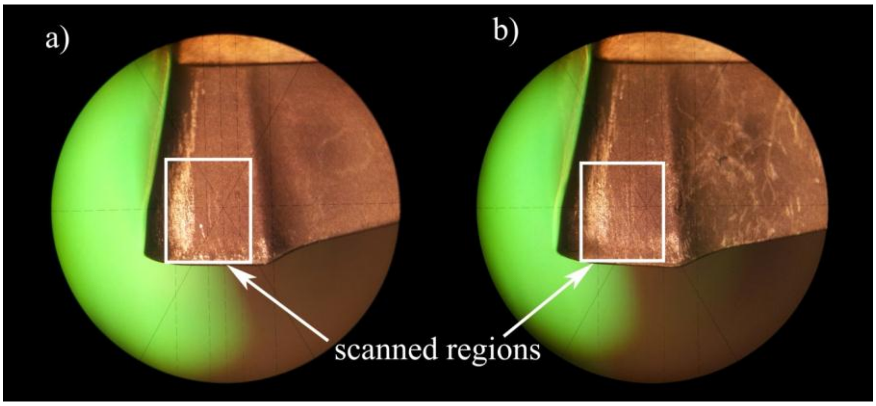

Fig. 2 Microscopic view of scanned regions: a) insert no. 1, b) insert no. 2 [source: own study]

3. RESULTS

Figure 3 shows the method of determining the radius of the cutting edge. Contact tip of measuring device moving in a perpendicular direction to the cutting edge determines the edge contour. The software allows entering the arc in the scanned contour and determination of the radius of the edge. Compensation of measuring tip radius is included. In Figures 4 and 5 views of scanned flank faces and the shape around edges are shown. Rectangular areas with dimensions of 1.4 x 2 mm were scanned.

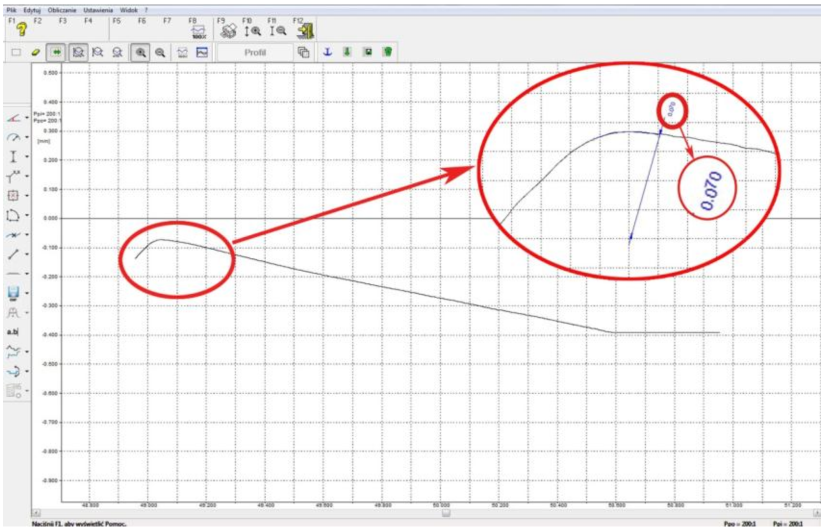

Fig. 3. Measurement of edge rounding [source: own study]

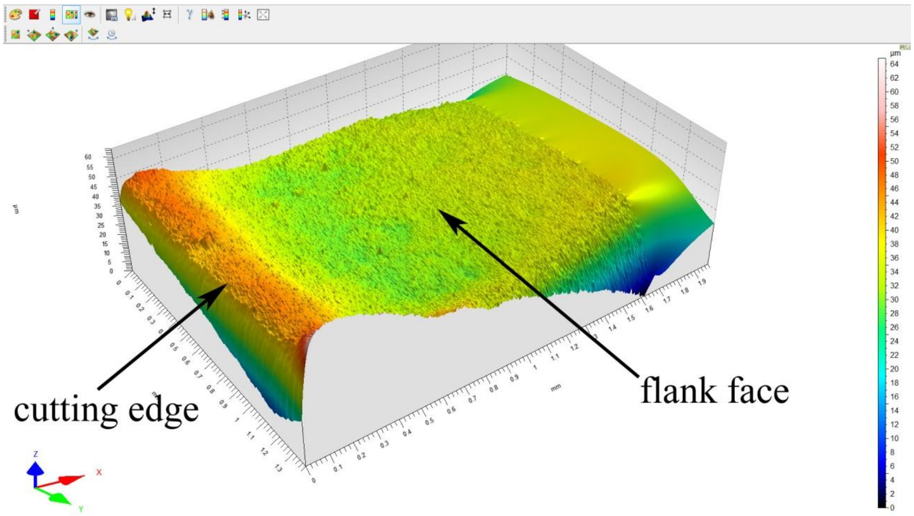

Fig. 4. Flank face topography of insert no. 1 [source: own study]

On the basis of the presented topography, there was no significant tool wear of working surfaces and the unfavorable state of the cutting edges.

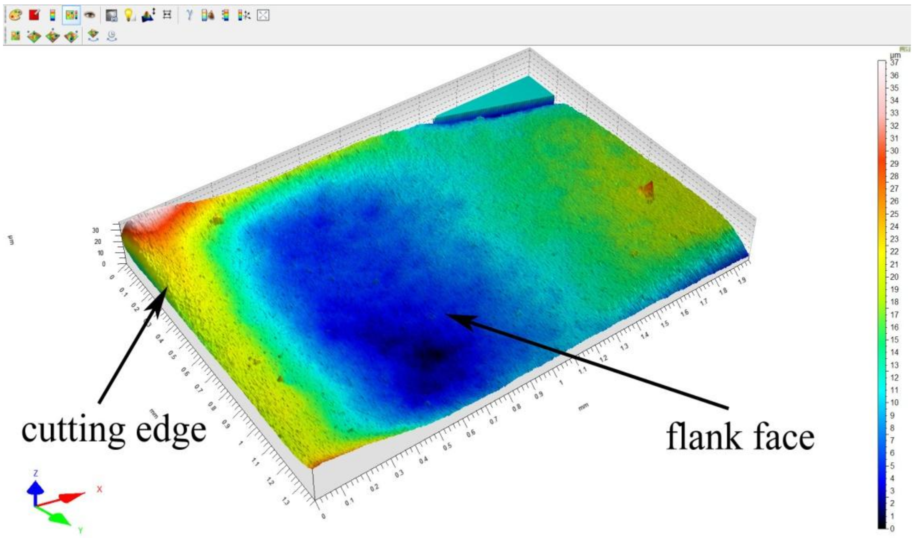

Fig. 5. Flank face topography of insert no. 2 [source: own study]

In addition, 3D map can be represented in 2D and perform measurements of length, angle and area. Measurement of the length shown in Fig. 6

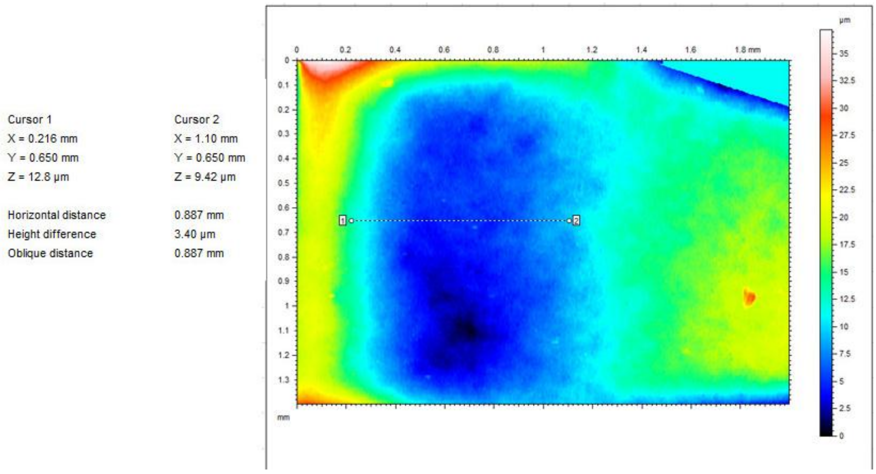

Fig. 6. Length measurement on the 2D map [source: own study]

4. CONCLUSIONS

The article presents the results of tool wear measurement after machining of AlSi10Mg aluminum alloy. The experiment was carried out using combined roughness and contour device. This method allows to measure the full analysis in terms of tool wear indicators. The ability to analyze the 3D map offers more information about the tested surfaces. In addition, on the flank face scanned map all tool wear indicators can be measured. On the basis of the conducted experiment, a significant tool wear was found after machining of AlSi10Mg aluminum alloy. One can expect a higher tool wear after machining of aluminum alloys with a high silicon content above 20%.

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