XVI IMEKO World Congress
Measurement - Supports Science - Improves Technology - Protects Environment ... and Provides Employment - Now and in the Future
Vienna, AUSTRIA, 2000, September 25-28

SOME SHAPE MEASUREMENT PROBLEMS OF MICRODETAILS

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Abstract: Last years the scale of microsystems production is higher and higher. Because of this fact the requirements for traditional measurement equipment applied for measurement and control of microdetails geometry are changing. These changes are connected with new needs in the range of measurement and programme possibilities. In the paper the examples of microdetails measurements carried out using PG-2/200 Form Meter, which was worked out and produced at the Institute of Metal Cutting are presented. The analysis of measured microdetail profiles contains linear dimensions, angles and radii. The examples of measurement accuracy analysis carried out using PG-2/200 Form Meter for standard details are also presented. The aim of this analysis is to define the range of traditional form meters application in small surface geometry measurements.

Keywords: shape measurements, dimensional inspection, 3D surface topography

1 PREFACE

Last years the scale of microsystems production is higher and higher. Because of this fact the requirements for traditional measurement equipment applied for measurement and control of microdetails geometry are changing. These changes are connected with new needs in the range of measurement and programme possibilities. Bellow the examples of microdetails measurements carried out using PG-2/200 Form Meter, which was worked out and produced at the Institute of Metal Cutting are presented.

2 MEASURING STAND DESCRIPTION AND MEASUREMENTS ANALYSIS RANGE

PG-2/200 Form Meter (Fig. 1) designed and made in The Institute of Metal Cutting in Cracow, is intended for surface roughness measurement using contact method.

Figure 1. PG-2/200 Form Meter made in IOS.

Basic technical data of PG2/200 Form Meter:

- measurement range for standard arm 200 mm	10 mm
- maximum length of measurement travel	200 mm
- minimum length of measurement travel	1 mm
- speed of measuring head travel	0.1; 0.2; 0.5; 1.0 mm/s
- measuring converter	inductive.

Drive unit, hanged on a column positioned on granite plate, moves inductive measuring head along measured surface transferring measured signal through measuring system and 16 bit A/D converter to computer.

Special software permits for dimensioning of selected parameters of the measured shape, including defined distances, height of any points, angles and radii. Program also gives possibility of rotation and zooming of measured profile, creating files on the disk for further processing and analysis, printing of the desired shape with values determined during analysis in the form of measurement protocol.

Stereometric measurements - 3D, being an expansion of measuring possibilities 2D of the meter, are performed using scanning table controlled by the program. Measured surface is moved using scanning table in the direction perpendicular to direction of head movement by entered constant step. Space measurement cycle is performed in automatic mode.

Results of stereometric measurements are data files, which allows multiply processing and analysis. The program allows presentation of 3D stereometric view of measured surface and construction of contour maps (with determining number, level and colours of contours).

Additionally it is possible to calculate capacity of material (or loss) on chosen area of flat, cylindrical or spherical measured surface in relation to reference surface and to calculate cylinder and sphere radii from chosen sector of measured surface.

Below the applications of PG-2/200 Form Meter for surface geometrical structure measurements in the small geometrical quantities are presented (Fig. 2).

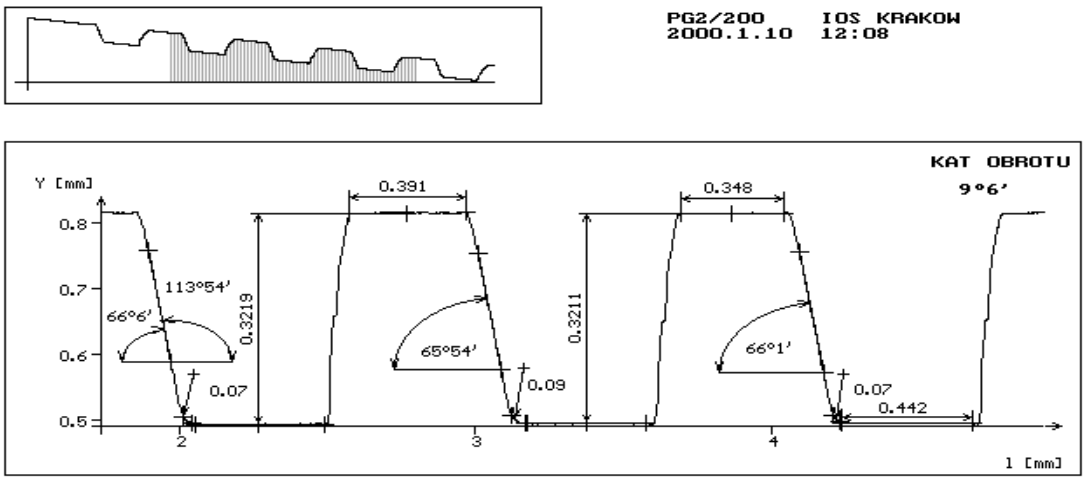

Figure 2. Example of measurements protocol on the surface after precision electrochemical machining

Following parameters can be calculated by programme:

- distances,
- angles,
- radii and circle deviation,
- areas to reference base.

The following types of points from measurement and calculations can be chosen for analysing:

- points of measurement,
- max and min of the sector of the shape between 2 points,
- centre of the circle,
- intersection point of two lines,
- average height of sector of the shape.

Dimensioning can be determined in the following directions:

- in the directions of an X and Y axis,
- in the direction from point to point - on the XY plane.

Measurement protocols can be printed out or saved in computer memory in the form of file prepared for printout. Besides the possibility of determining parameters according to standards it is possible to expand chosen section of profile using ZOOM function and to print it out.

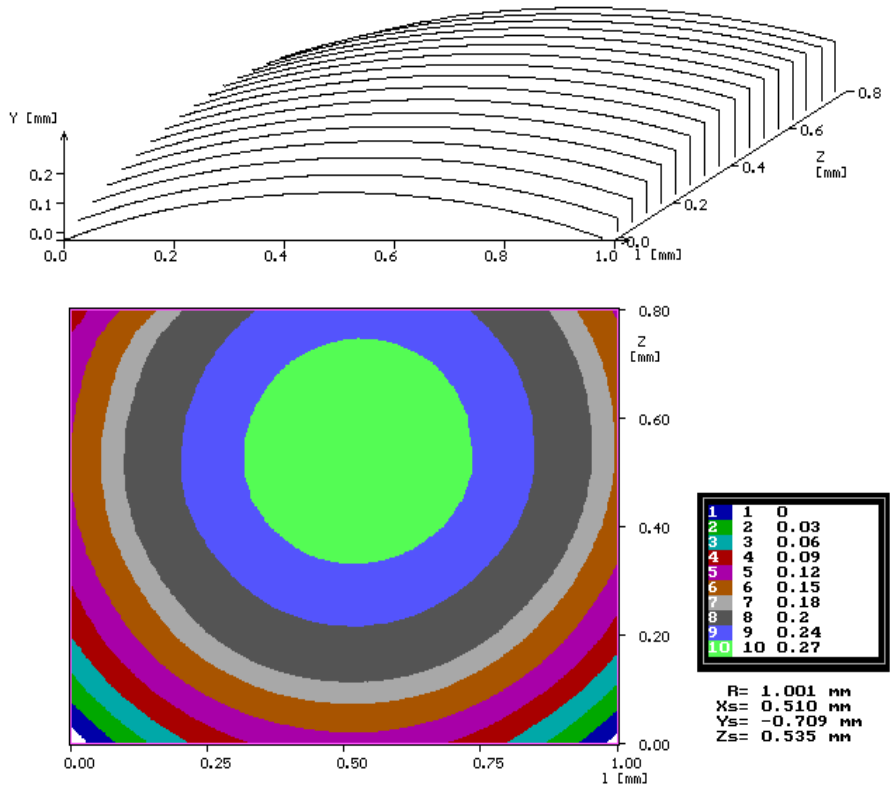

Figure 3. Stereometric view, contour map and calculated radius of small sector of bearing ball.

Graphical presentation of stereometric view and contour map allows observation of distribution on material surface after machining or damages caused by improper machining. Additional analysis and calculations can be done on the base of these observations.

Additionally it is possible to calculate capacity of material (or loss) on chosen area of flat, cylindrical or spherical measured surface in relation to reference surface and to calculate cylinder and sphere radii from chosen sector of measured surface. And it is possible to determine radius if only part of cylinder or sphere is accessible to measure (Fig. 3).

3 MEASUREMENTS AND ANALYSIS OF STANDARD DETAILS

Precision examinations on small value distances, angles and small radii measured on short distances were carried out. Measurements were done using standard cone edge with radius curvature about 20 µm. Better results can be achieved if the edge with precisely done radius curvature about 5 µm would be applied.

Some examples of measurement accuracy analysis carried out using PG-2/200 Form Meter for standard details: standard plates of length, standard plates of angles and small radiuses control rollers were presented in Fig. 4.

The analysis of above mentioned problems and performed measurements allow defining the range of traditional PG-2/200 Form Meter application in small surface geometry measurements. It is possible to perform precision measurements on micro surface by this instrument.

Achieved results of performed control measurements and analysis allows to estimate possible to obtain measurements accuracy: distances smaller then 2.5 mm with accuracy 0.1µm, angles on 1mm sectors with accuracy 2 minutes and small radiuses on short sectors with accuracy about 10 µm.

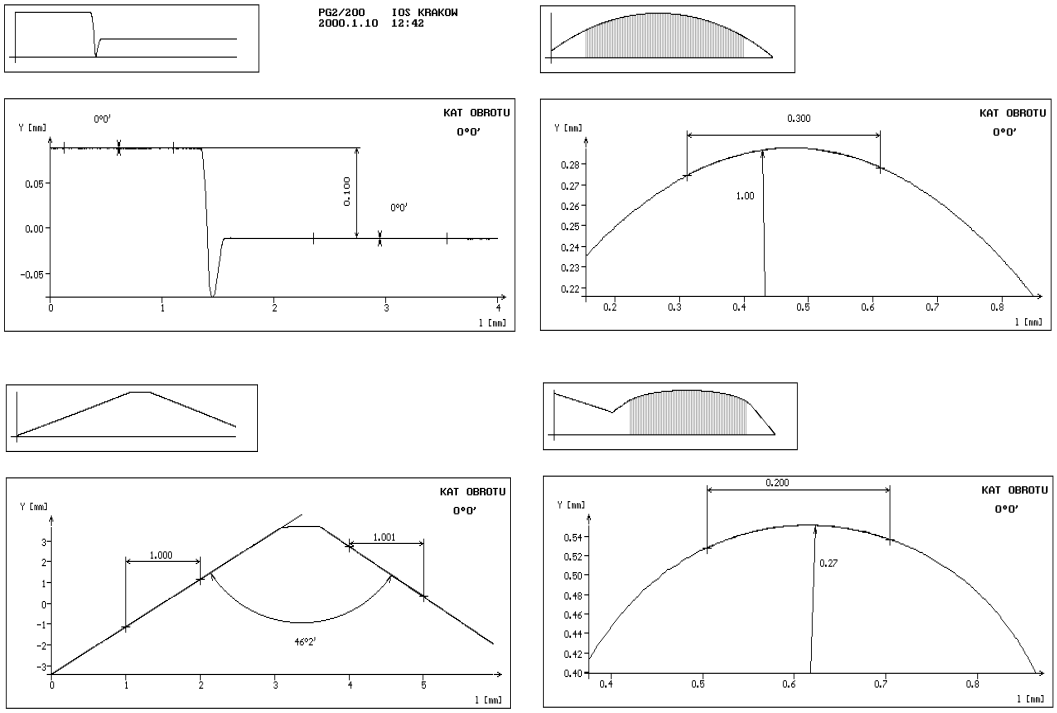

Figure 4. Examples of PG-2/200 Form Meter measurement protocols of standard elements.

4 SUMMARY

PG-2/200 Form Meter and enclosed software is very convenient for surface geometrical structures measurements including microdetails and dimensioning of their parameters. The possibility of measurements and analysis using computers allows complex assessment of different machining details in the standard range and also in the microgeometry range.

The possibility of measurements of small parts values and short distances is very difficult or even impossible by another methods and it is very easy to perform by this instrument.

Graphical presentation of stereometric view and contour map allows observation of directional machining traces, distribution of material defects and deformations, analysis and evaluation of tools usage.

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