ME-372 : Heat transfer and Metrology lab

Experiment No.- 1 A

3D Surface Characterization on ZETA Microscope

Contents

- **Theory**
  - Introduction of Surface roughness
  - Types of Surface roughness measurement
  - Objective
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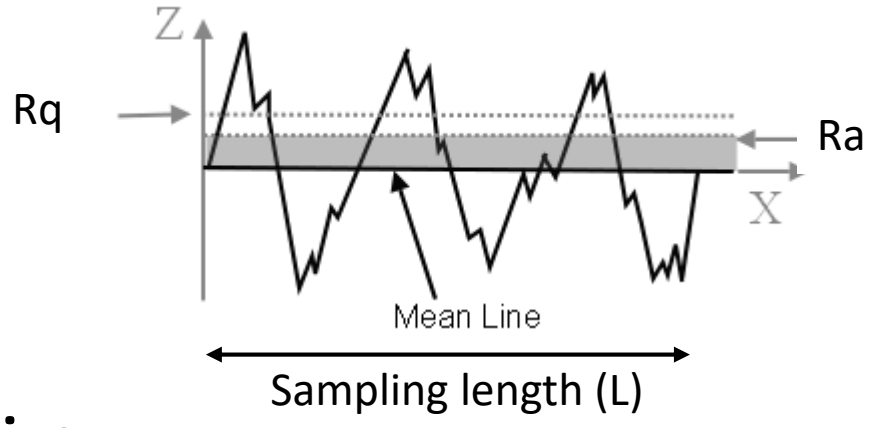
Introduction

- Surface roughness is defined as the irregularities and unevenness present on a finished surface after machining.
- Surface roughness indicates quality of that surface. Surface roughness can be measured quantitatively.
- Surface roughness measurement is non-destructive test.
- Average surface roughness (Ra) measured as the arithmetic averages of the absolute values of all the deviations of peaks from the mean line.
- Root Mean Square surface roughness (Rq) measured as the arithmetic RMS of the absolute values of all the deviations of peaks from the mean line.



$$Ra = \frac{\int_0^L |z(x)|\, dx}{L}$$

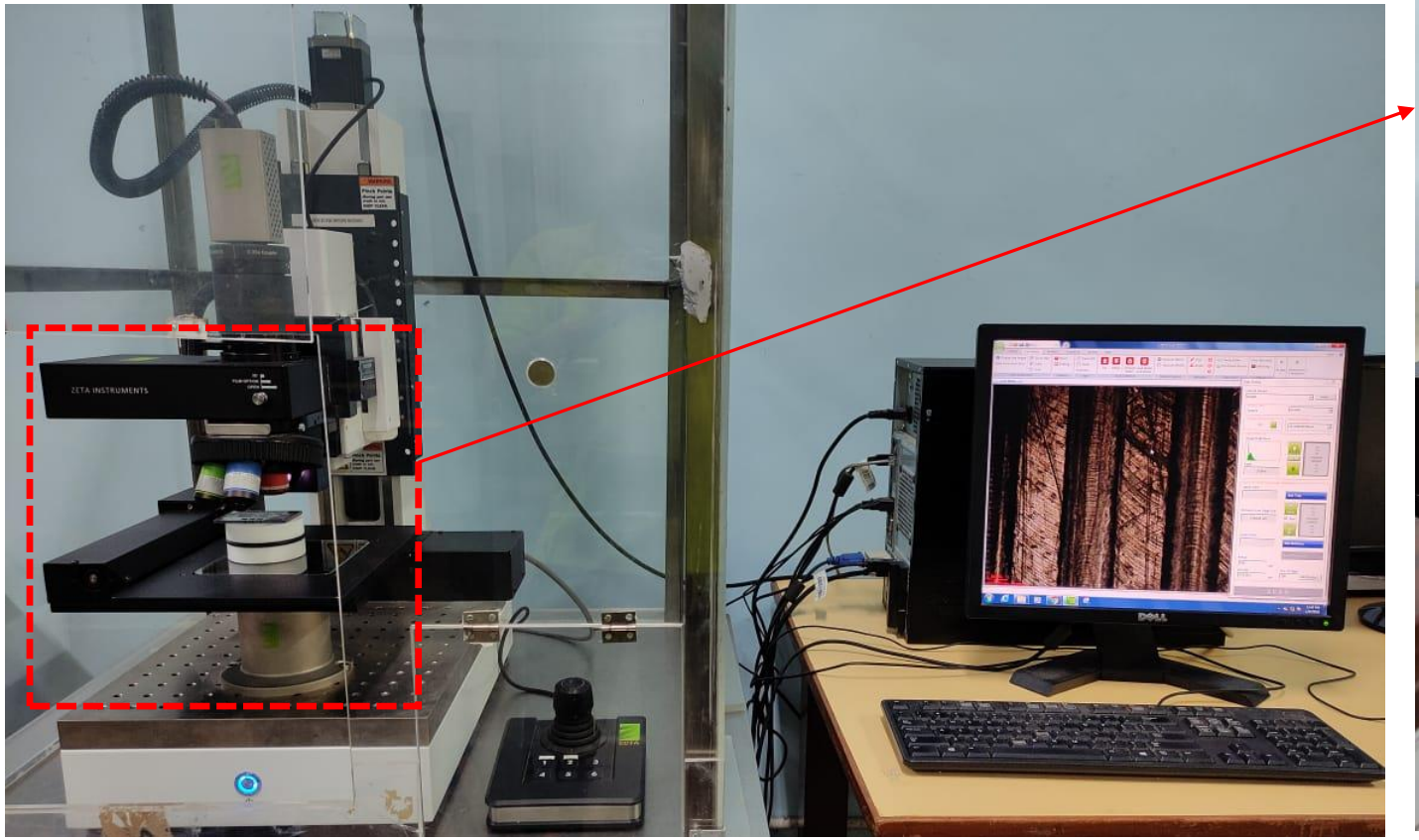
$$Rq = \sqrt{\frac{\int_0^L (Z(x))^2 dx}{L}}$$

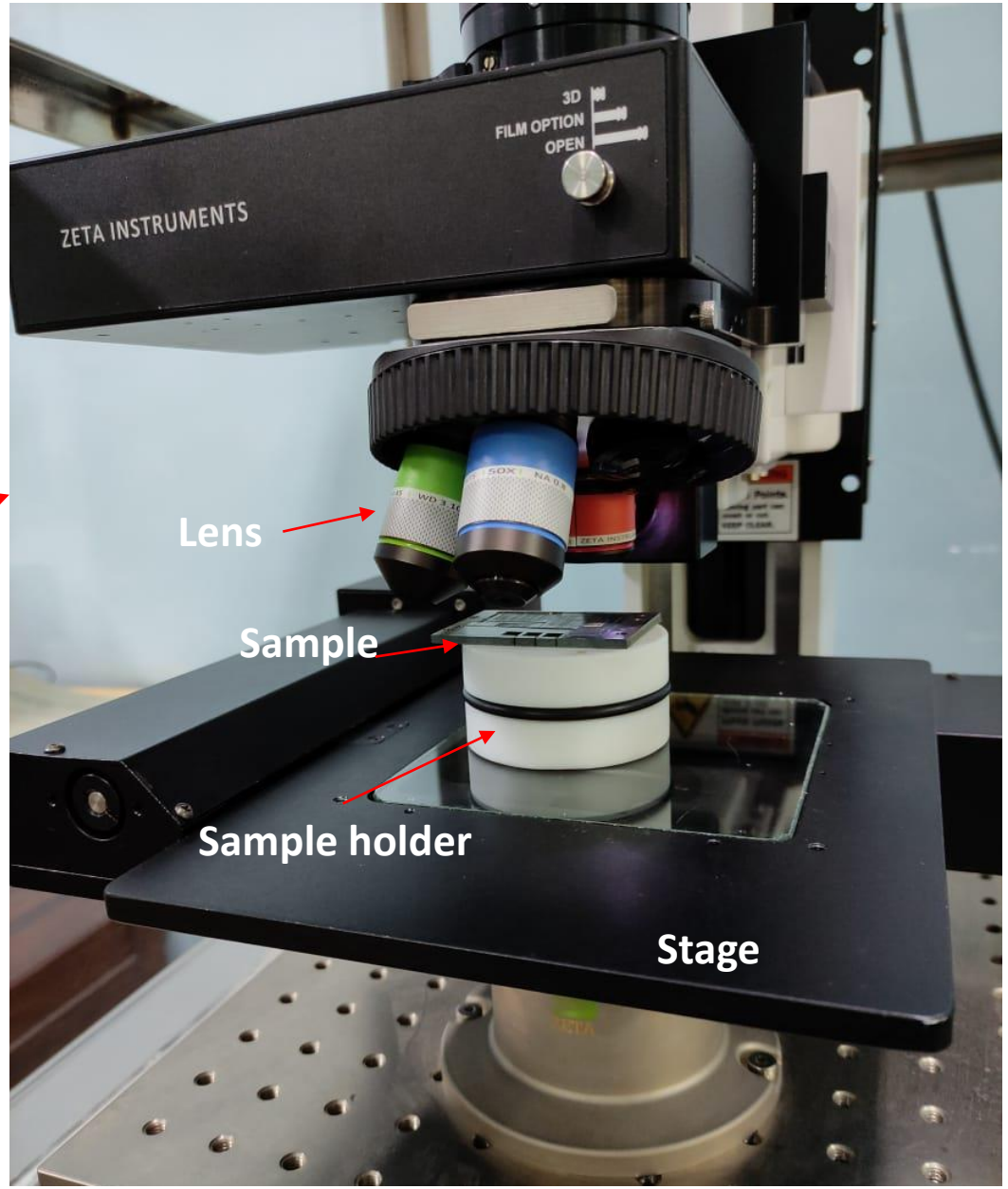
Objective:-

- Following surface characterization of sample using ZETA Optical Microscope to be performed.
- Step height measurement of a micro-channel fabricated on a steel substrate.
- Surface roughness measurements of EDM sample.

Optical microscope

3D Optical Microscope





Procedure

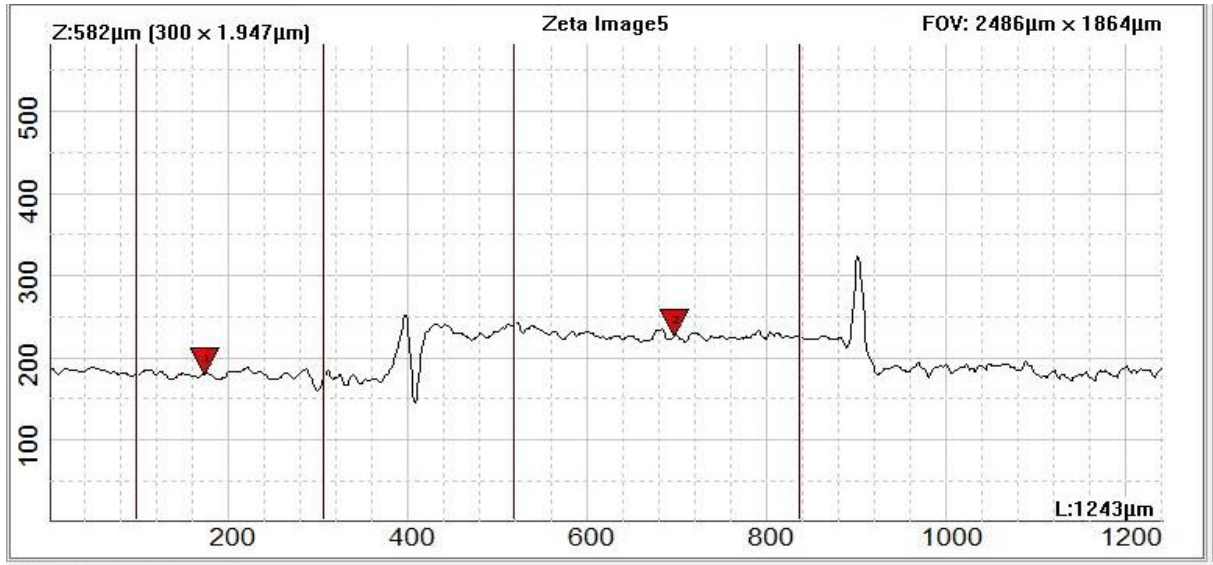
1. Place the sample under the lens in such that the region to be studied is in frame and choose the appropriate magnification.
2. Use “page up” and “Page down” to focus the image. Select lower limits and upper limits.
3. Set the step size. Then scan the focused image to get image in 2D and 3D.
4. To measure average step height, we put left and right cursors to the regions for which we want the average step height.
5. To measure line roughness, create a line horizontally. Then calculate the Average and RMS surface roughness.

Precaution:-

To avoid affecting the test result, care must be taken to ensure that the test is not disturbed by any shock or vibration (i.e.- an anti-vibration table may be required).

Results and Analysis

Step height measurement



Zeta Analysis Report

Image Name: Zeta Image5 File Name:

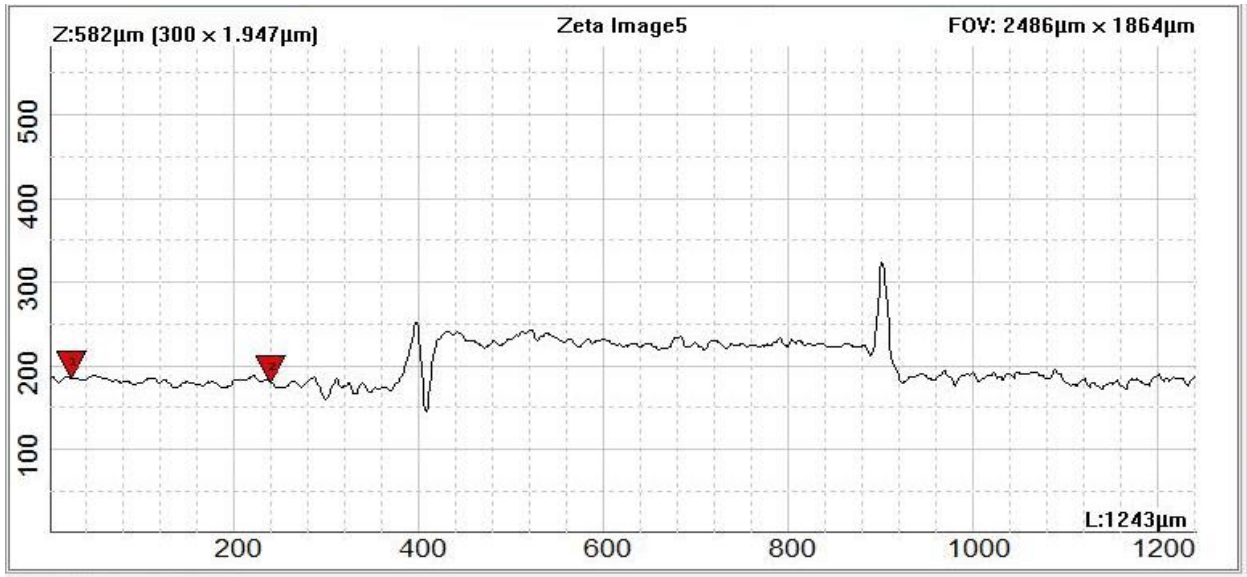
Date Acquired: Wed Jan 13 23:05:30 2021 Today: Wed Jan 13 23:25:37 2021

Z Range: 582µm No. of Steps: 300 Step Size: 1.947µm Field of View: 2486µm x 1864µm

	Cursor Left		Cursor Right		Cursor L-R			Markers 1-2		
	Avg Ht	Width	Avg Ht	Width	Step	Dist	Angle	Step	Dist	Angle
1	178.90	208.65	227.35	318.19	48.45	475.55	5.818	46.59	524.29	n/a

Results and Analysis

Surface roughness measurement



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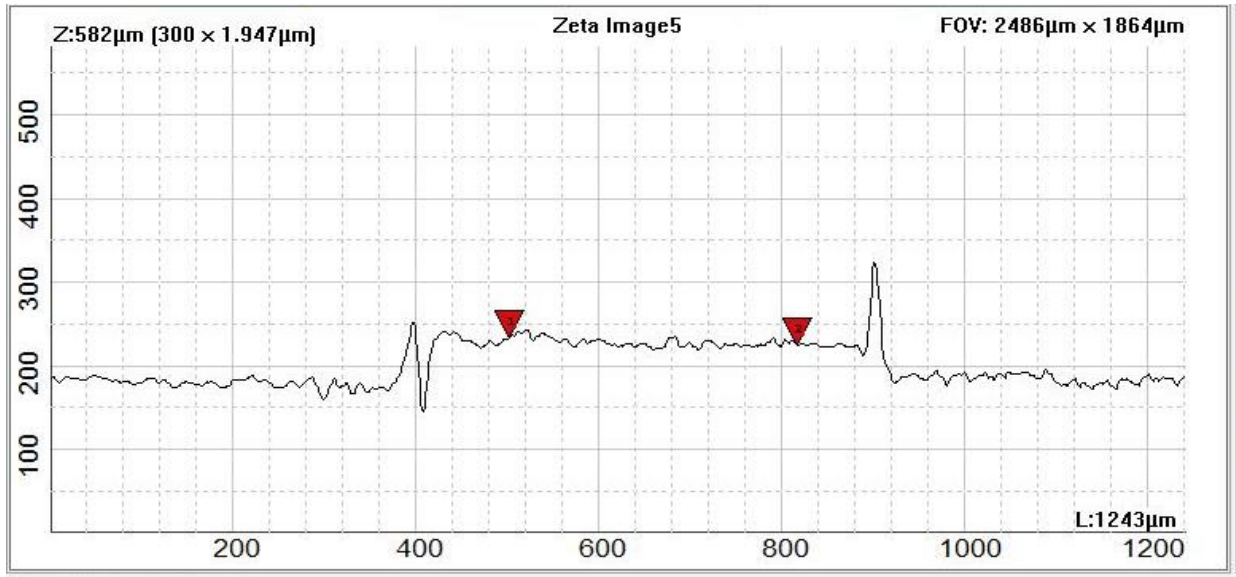
Date Acquired: Wed Jan 13 23:05:30 2021 Today: Wed Jan 13 23:25:37 2021
Z Range: 582µm No. of Steps: 300 Step Size: 1.947µm Field of View: 2486µm x 1864µm

	Markers 1-2							
	Ra	Rq	Rpv	Rp	Rv	Rsk	Rz	Rku
	2.687	3.347	16.47	8.547	7.926	-0.1112	6.628	2.724

Results and Analysis

Surface roughness measurement



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Z Range: 582µm No. of Steps: 300 Step Size: 1.947µm Field of View: 2486µm x 1864µm

	Markers 1-2							
	Ra	Rq	Rpv	Rp	Rv	Rsk	Rz	Rku
	3.470	4.348	18.75	10.34	8.412	0.3331	14.78	2.485

Report contents (in your own words)

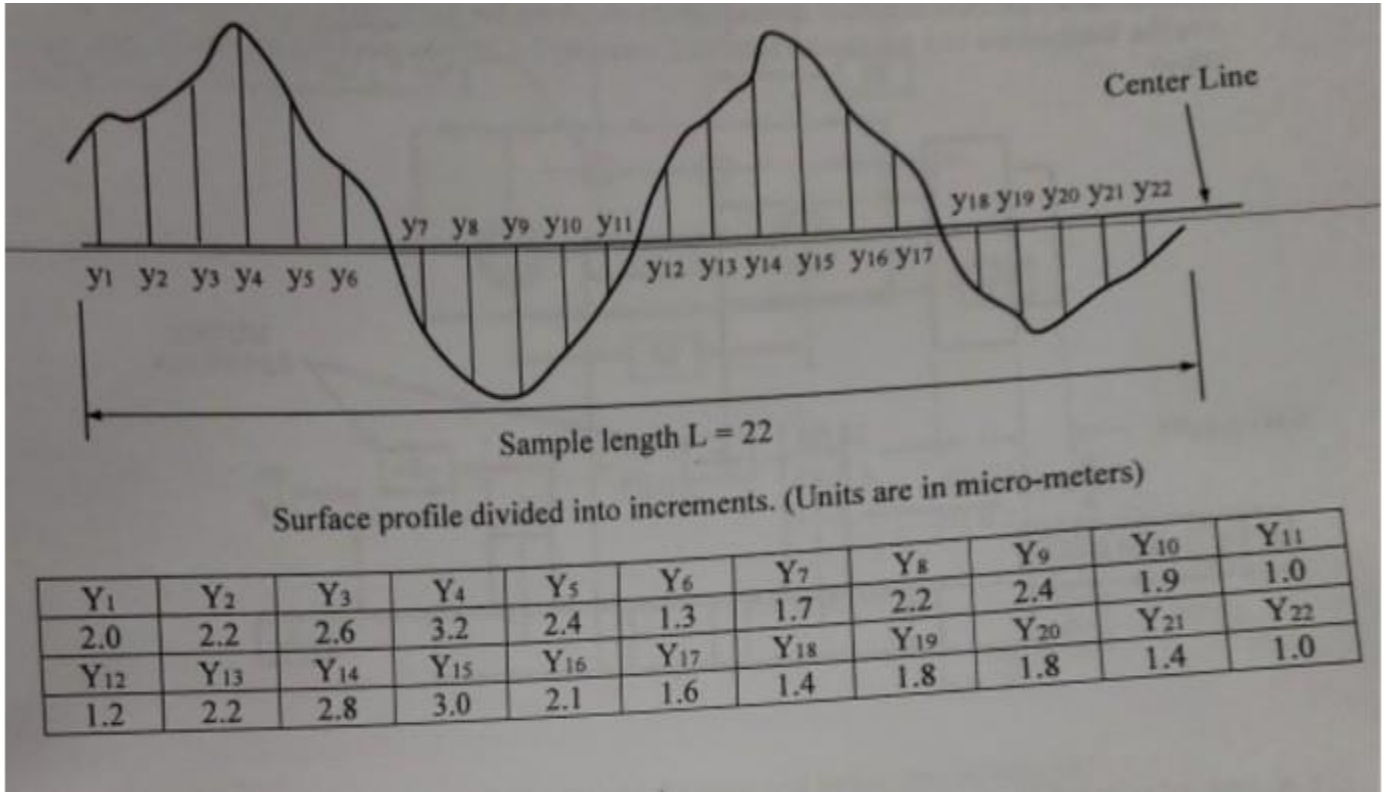
Question 1. Write objective of this experiment.

Question 2. Write the working principle of 3D Optical microscopy. And also draw the schematic diagram for the same.

Question 3. Write the types of surface roughness with their formulas. Present those in the schematic diagram.

Question 4. Write the Conclusions and the sources of errors in this experiment.

Question 5. The following readings were taken from the surface profile diagram given below calculate the Ra and Rq surface roughness.



Surface profile divided into increments. (Units are in micro-meters)

Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8	Y_9	Y_{10}	Y_{11}
2.0	2.2	2.6	3.2	2.4	1.3	1.7	2.2	2.4	1.9	1.0
Y_{12}	Y_{13}	Y_{14}	Y_{15}	Y_{16}	Y_{17}	Y_{18}	Y_{19}	Y_{20}	Y_{21}	Y_{22}
1.2	2.2	2.8	3.0	2.1	1.6	1.4	1.8	1.8	1.4	1.0