EXP1A - Group 24

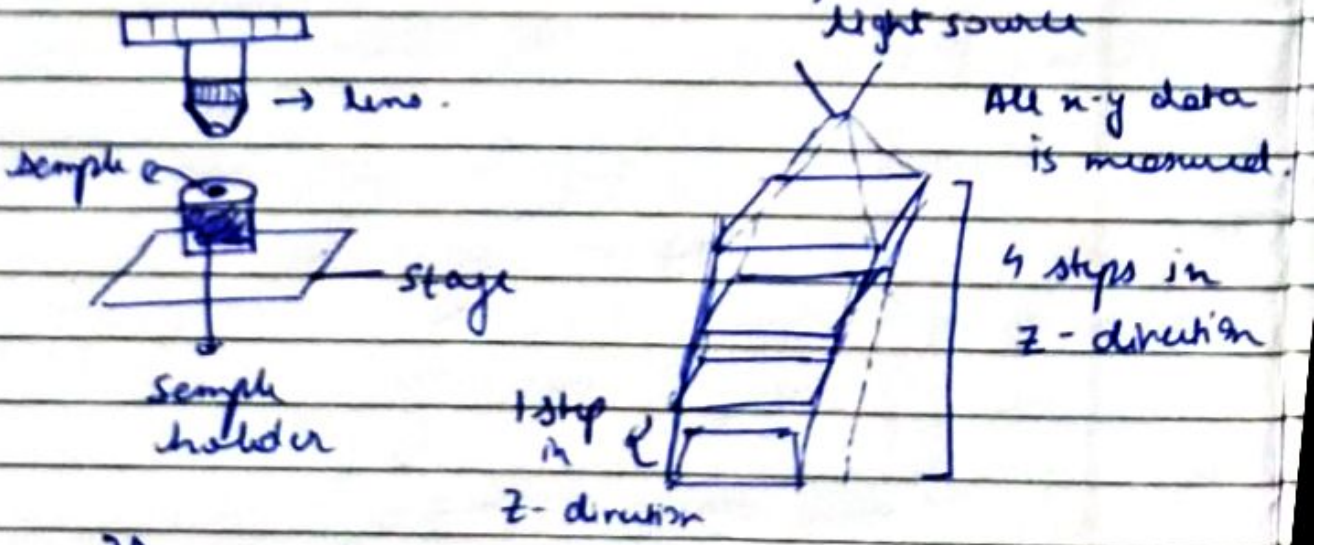
Experiment :— 3D surface characterisation on ZETA microscope

Objective: To do 3D surface characterisation of sample with the help of ZETA optical microscope and (I) measure step height of a microchannel fabricated on a steel substrate.
(II) Measure surface roughness of sample.

Theory:

⇒ Working principle of 3D optical microscopy

The 3D optical microscope advances vertically in steps & thus puts focus on various layers of the surface in z-direction for a particular field of view. The software then stitches up the layers together and creates a 3D reconstruction of the sample.



3D-optical microscope

Working Principle

⇒ Types of rough surfaces.

① Arrays surface roughness (R_a)

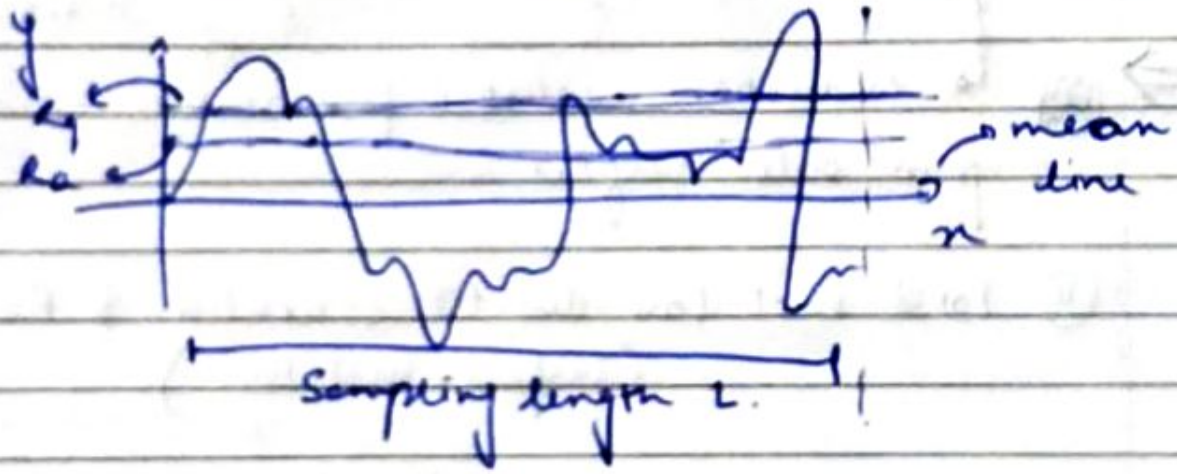
R_a is the arithmetic avg of the absolute values of the roughness profile ordinates from the mean line over a sampling length.

$$R_a = \frac{1}{L}\int_0^L |y(x)|\, dx$$

② Root mean sq. surface roughness (R_q)

R_q is defined as the arithmetic Root mean square of the absolute values of the roughness profile ordinates from the mean line over a sampling length.

$$R_q = \sqrt{\frac{1}{L}\int_0^L (y(x))^2\, dx}$$



Q4) Conclusions:

1. We have used 10 lines with 20 um spacing for taking the height and surface roughness readings.
2. 500 steps have been used for scanning. Accuracy can be improved with more steps, however, that would take longer to compute.
3. When the left cursor is placed in the first valley and the right cursor brackets the first peak, the mean step height is found to be 46.13 um. Mean peak height is 269.48 um while mean valley height is 223.35 um.
4. Burr formation is observed in the transition zone between the valley and peak regions. The maximum burr height observed is close to 582 um with reference to the valley depth height.
5. For the surface roughness calculation in the peak region, the Mean Average Surface Roughness (Ra) was found to be 5.065 um and the Mean Root Mean Square Surface Roughness (Rq) value was found to be 6.348 um.

Sources of Error:

1. There should be no vibration or shock during the test. An anti-vibration table is preferred to minimize the errors due to vibrations.
2. The number of steps should be high enough to provide for an acceptable accuracy during scanning.
3. Any kind of external particles on the surface of the sample will create errors, thus, the sample must be free from dust and other particles during the test.
4. Burr formation can lead to errors if not excluded in the selection of peak and valley areas with the cursor.

Q5) By definition,

$$R_a = \frac{\sum_{i=1}^{N} Y_i}{N} \qquad R_q = \left(\frac{\sum_{i=1}^{N} Y_i^2}{N}\right)^{1/2}$$

Here, $N = 22$ $\qquad N = 22$ (given)

$$\therefore R_a = \frac{(2.0+2.2+2.6+3.2+2.4+1.3+1.7+2.2+2.4+1.9+1.0+1.2+2.2+2.8+3.0+2.1+1.6+1.4+1.8+1.8+1.4+1.0)}{22}$$

$$= \boxed{1.9636 \text{ um}}$$

$$\therefore R_q = \left(\frac{92.88}{22}\right)^{1/2}$$

$$= (4.2218)^{1/2}$$

$$= \boxed{2.0547 \text{ um}}$$

Sr. No.	Y values	Y_squared values	
1	2	4	
2	2.2	4.84	
3	2.6	6.76	
4	3.2	10.24	
5	2.4	5.76	
6	1.3	1.69	
7	1.7	2.89	
8	2.2	4.84	
9	2.4	5.76	
10	1.9	3.61	
11	1	1	
12	1.2	1.44	
13	2.2	4.84	
14	2.8	7.84	
15	3	9	
16	2.1	4.41	
17	1.6	2.56	
18	1.4	1.96	
19	1.8	3.24	
20	1.8	3.24	
21	1.4	1.96	
22	1	1	
SUM	43.2	92.88	
SUM/N	1.963636364	4.221818182	
		2.054706349	**RMS Value**