Heidelberg Test on Grayscale Lithography

Introduction: *This is a document concerning the test writing on the grayscale lithography technique provided by the Heidelberg µPG 101 machine.*

Test Writing Process

1. Sample Preparation
   a. Prepare an RCA cleaned 3-inch glass substrate.
   b. Spin coating HMDS on glass, 60sec @ 5500rpm.
   c. Spin coating AZ P4210 (AZ4562) photoresist, 60sec @ 2500rpm.
   d. Soft bake in oven, 1hr @ 110^{o}C.

2. Grayscale Exposure
   Heidelberg µPG 101 machine provides the grayscale lithography function. The parameters for exposure are listed here:
   a. Laser power: 16mW
   b. Duration factor: 40%
   c. Grayscale: 50
   d. Design size: 2.5mm X 2.5mm with uniform grayscale
   e. Number of designs: 25 (5 X 5 array)

3. Development
   a. Develop in 352 developer for 2min.
   b. Rinse in DI water for 1min.

Optical Microscopic Images

The optical microscopic images of the test exposures numbered before #20 on glass substrate under front illuminations and 5X magnification are given in Fig. 1. Based on the observations, the artifacts are evident for the test exposures with numbers below #20. Next we will show microscopic images of the exposures numbered #20, #22 and #25, demonstrating that these seems to be better results.

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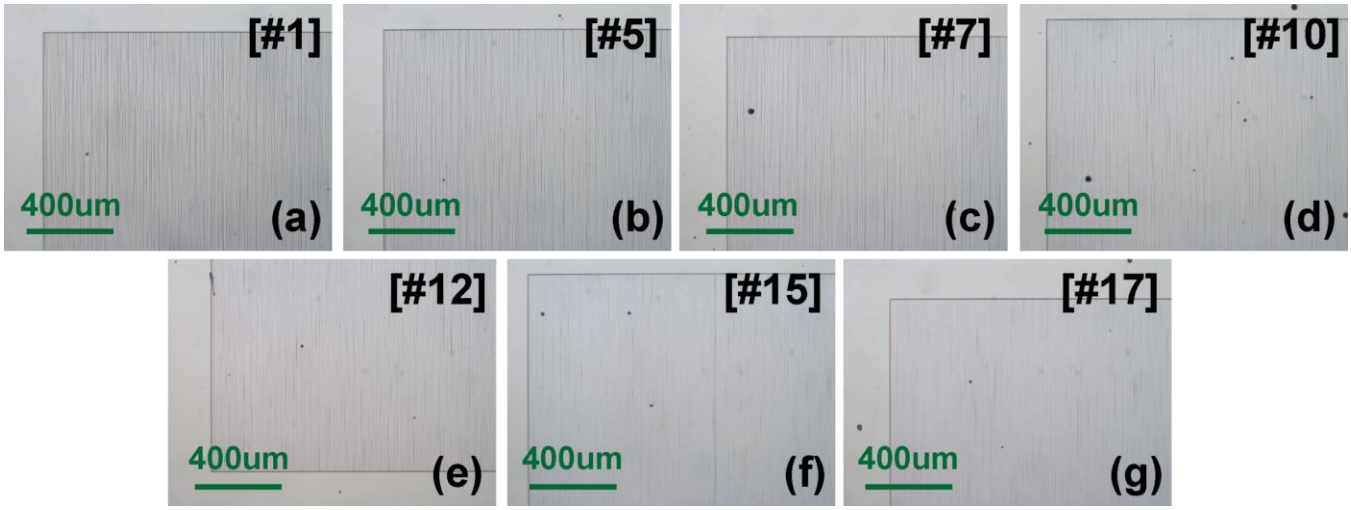

Figure 1 | Optical microscopic images of the test exposures numbered before #20 on glass substrate under front illumination and 5X magnification.

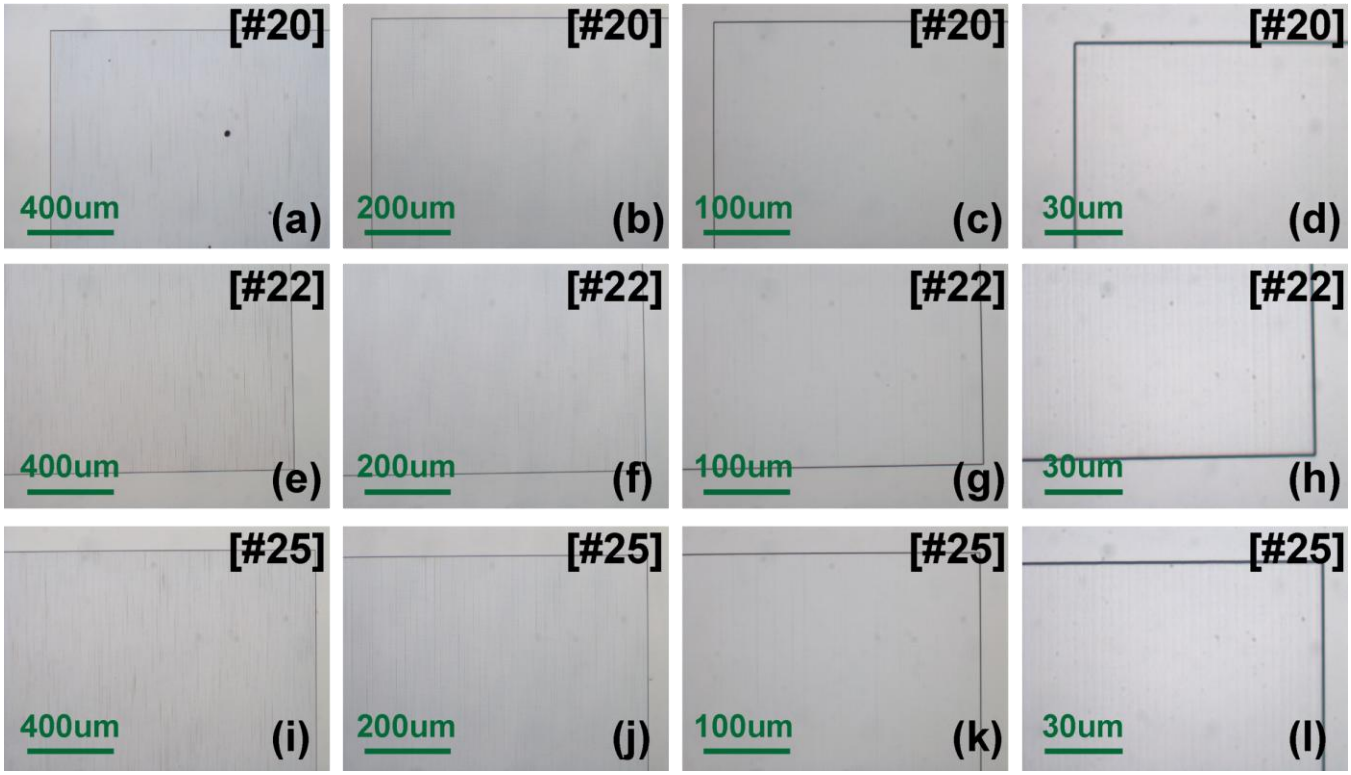

Figure 2 | Optical microscopic images of the test exposures numbered larger than #20 under front illumination. (a) – (d) #20. (e) – (h) #22. (i) – (l) #25. (a) (e) (i) are 5X magnification. (b) (f) (j) are 10X magnification. (c) (g) (k) are 20X magnification. (d) (h) (l) are 60X magnification.

Profilometer Measurement Results

The thickness of the spin coated film is about 2.902um.

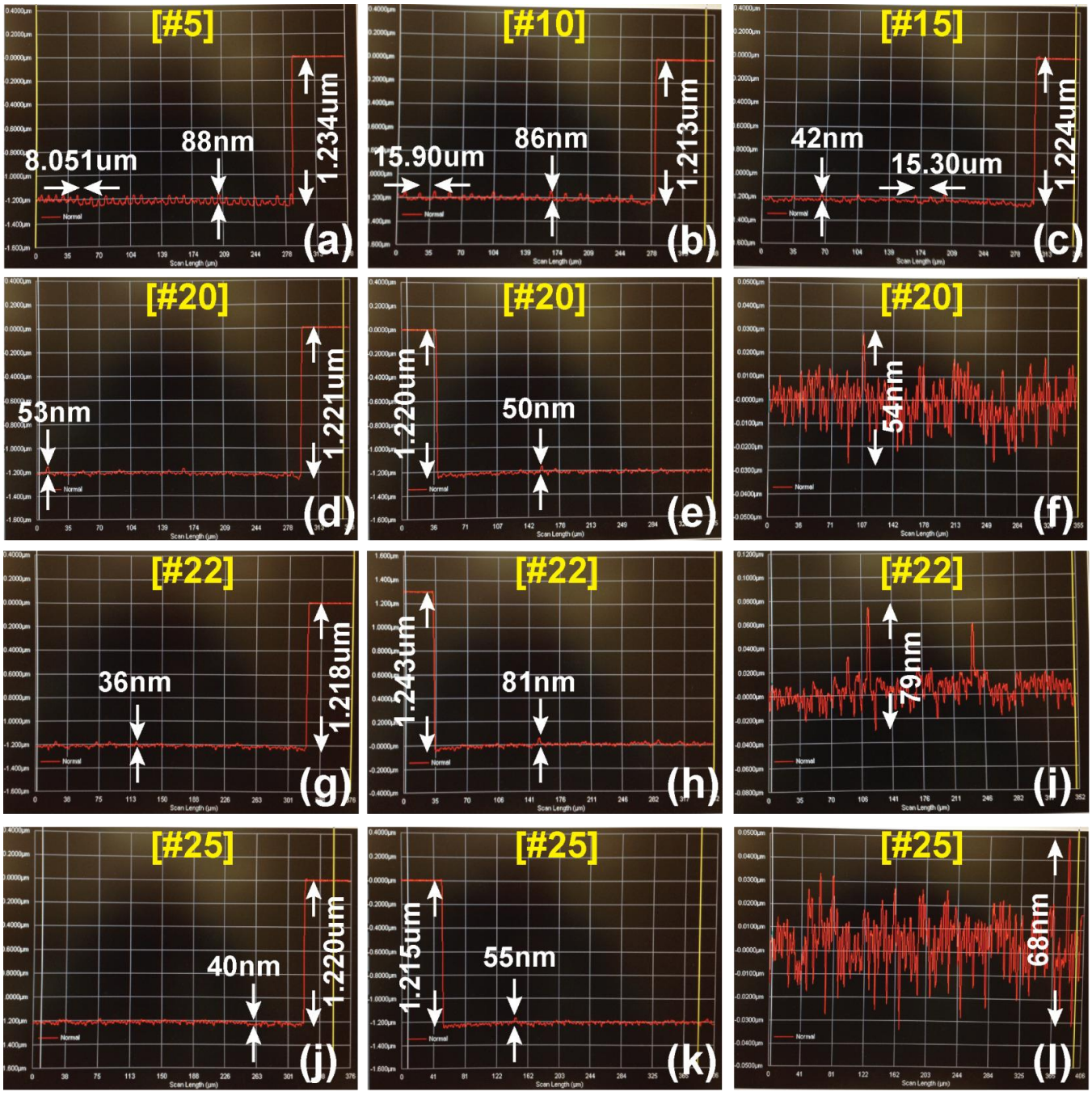

Figure 3 | Profilometer measurements. (a) – (c) The test exposures numbered before #20. (d) – (f) Measurements of #20. (g) – (i) Measurements of #22. (j) – (l) Measurements of #25. (d) (g) (j) are right edges. (e) (h) (k) are left edges. (f) (i) (l) are central regions. The labeled height difference measurements represent the maximum roughness within the exposure regions.

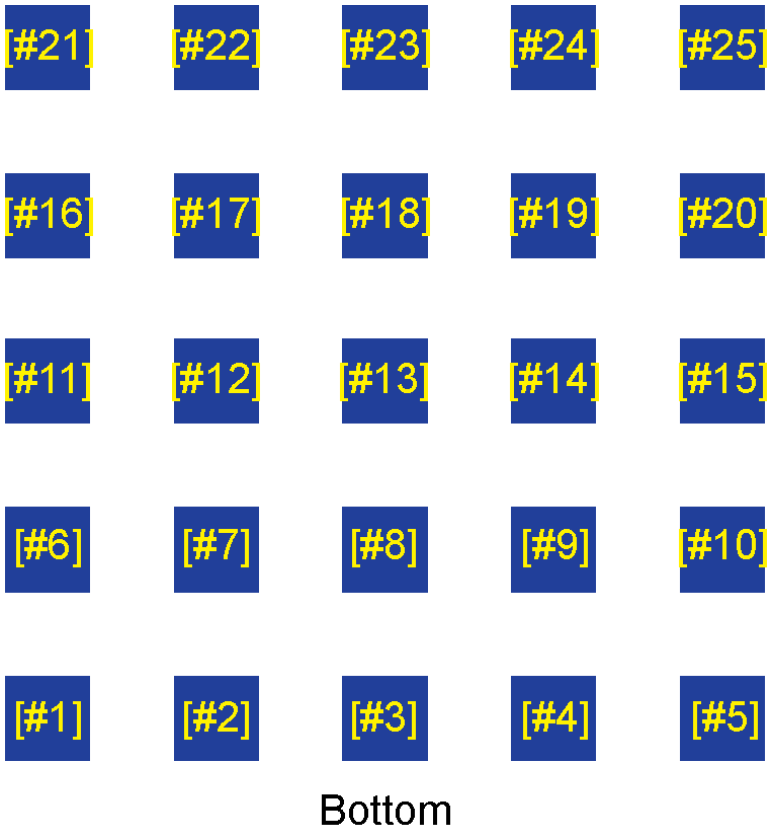

Figure 4 | Configurations of the text exposures.