Study on critical dimension of printable phase defects using an EUV Microscope

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EUVL is expected to be introduced into the manufacturing process at the 32-nm hp node between 2010 and 2013. However, significant developments are still needed especially in source, mask, and resist. In order to reduce a number of printable defects in an EUVL mask, we have developed an actinic mask inspection system since 2002 and observed phase defect images using bright field of Schwerzchild optics in the system. Thus we determined that pit and bump defects on glass substrate larger than 100 nm in width and 2 nm in height or depth are printable after deposition of Mo/Si multilayer[1-3)].

Furthermore, in order to clarify the critical size of printable defect and effect of planarization in multilayer deposition process, we prepared small pit defects with a depth of less than 2 nm by e-beam exposure and dry etching of glass substrate and deposited Mo/Si multilayer over the defects.

Figure 1 shows an observation result of the programmed pit defects on glass substrate. The programmed defect with a line width of over 100 nm and pit depth of over 2.5 nm was observed clearly by the EUV microscope. However, the programmed defects with a 75-nm width and a 1.5-nm depth could not be observed. Figure 2 shows the summary of defect printability results. With these results, we determined that the critical dimension of printable defects on glass substrate is 100 nm in width and 2.0 nm in depth.

In this paper, further study on printable and unprintable defect size will be presented and planarization effect of multilayer deposition over defects on glass substrate will be discussed.

Reference

1) K. Hamamoto, Y. Tanaka, H. Kawashima, S. Y. Lee, N. Hosokawa, N. Sakaya, M. Hosoya, T. Shoki, T. Watanabe, and H. Kinoshita, Jpn. J. Appl. Phys. **44**, 5474 (2005).
2) K. Hamamoto, Y. Tanaka, H. Kawashima, S. Y. Lee, N. Hosokawa, N. Sakaya, M. Hosoya, T. Shoki, T. Watanabe, and H. Kinoshita, J. Vac. Sci. Technol. B**23**, 2852 (2005).
3) K. Hamamoto, Y. Tanaka, H. Kawashima, S. Y. Lee, N. Hosokawa, N. Sakaya, M. Hosoya, T. Shoki, T. Watanabe, and H. Kinoshita, Jpn. J. Appl. Phys. **45**, 5382 (2006).

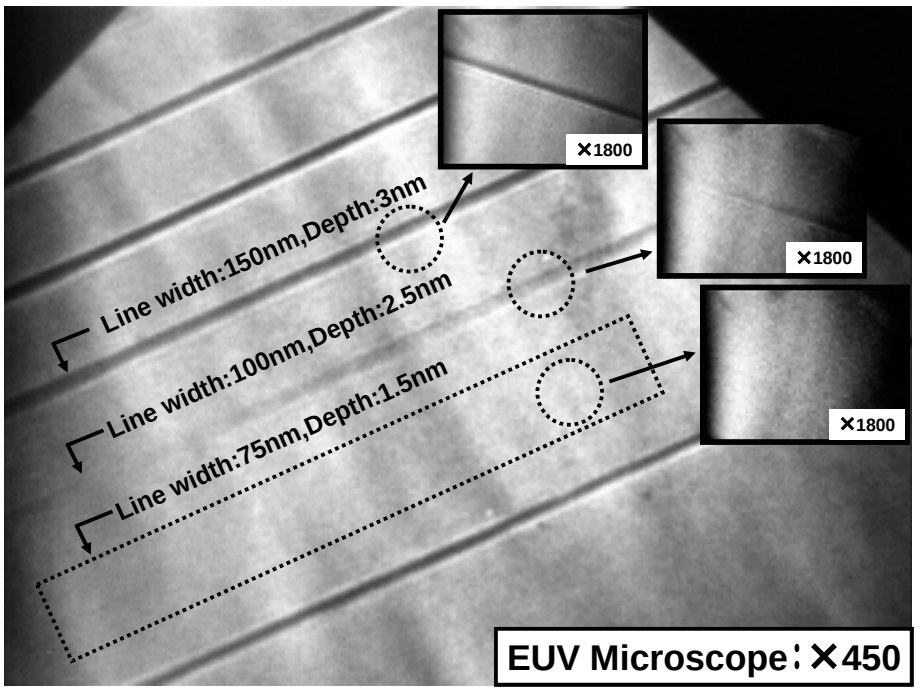

Fig. 1: An EUV microscope image of programmed phase defects.

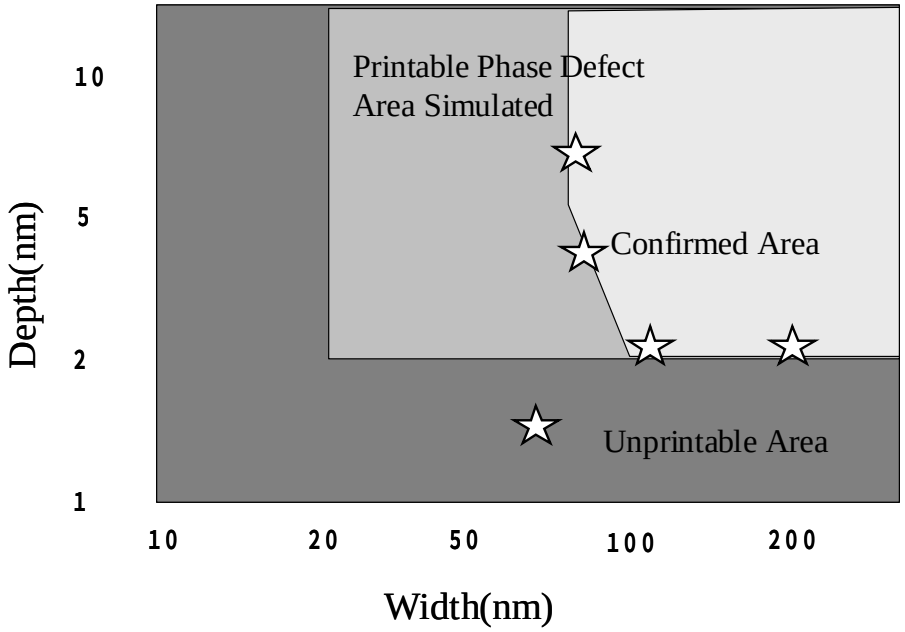

Fig. 2: A printability diagram for phase defect in an EUVL mask blank.