Thermal Analysis with High Accuracy of Multi-beam Mask Fabrication

Yanjun Zhang, Zhuming Liu

Institute of Semiconductors, Guangdong Academy of Sciences, Guangzhou 510651, Guangdong, China.

liuzhuming@gdisit.com

Abstract

For 7 nm technology node and beyond, multi-beam mask fabrication based on charged particle attracts attention widely and shows great advantages in throughput [1]. However, heating effect during mask writing is a serious problem, and make the problem of CD (critical dimensional) error. To improve the CD accuracy of the mask, the accurate analysis of heating with multi-beam writing is necessary [2].

In this study, the thermal effect of the electron beam on photoresist and substrate during lithography was simulated with a finite element numerical method. The variation in the temperature field with the scanning speed, scanning path, beam spot, and other process parameters of the mask writer were also analyzed. In addition, the stress field of the mask is analyzed through the thermal-mechanical coupling model, and the influence of different process parameters on the stress field distribution of the mask is discussed, and the temperature and stress on the typical scanning path are studied. The numerical research shows that the thermal analysis method in the study provides a guide to optimize process parameters of mask fabrication.

[1] Platzgummer E., Klein C., Loeschner H., "Electron multibeam technology for mask and wafer writing at 0.1 nm address grid", *Journal of Micro/Nanolithography, MEMS, and MOEMS*, 12 (3), 031108 (2013).

[2] Lee S.H., Choi J., Lee H.J., et al., "Challenges and Technical Requirements for Multi-Beam Mask Writer Development", *Proceedings of SPIE*, 9256, 925606 (2014).

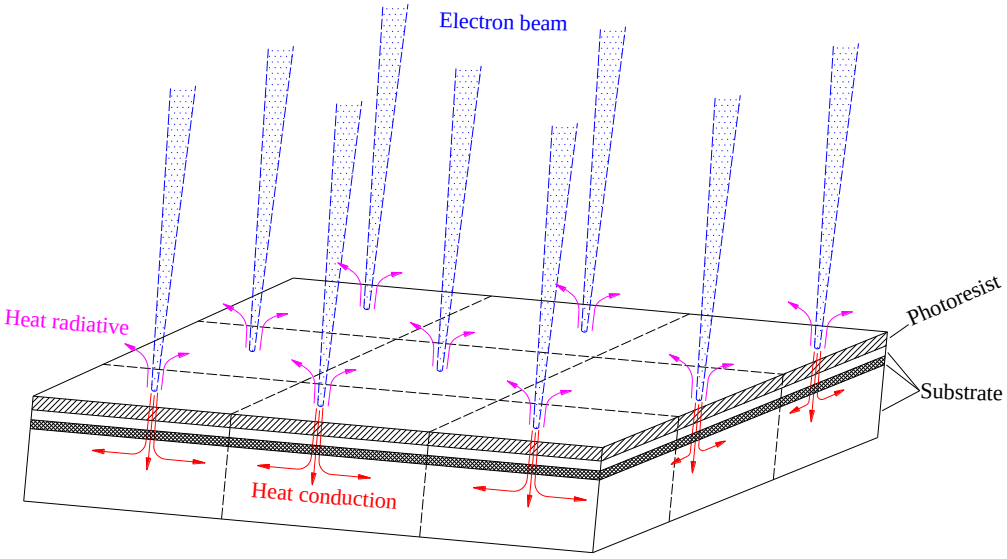

Figure 1: Heat exchange diagram of multi electron beam scanning during mask writing. Considering the vacuum environment in writing chamber, the heat convection between the photoresist and environment is ignored.