Resolution enhancement of EUV microscope using an EUV beam splitter

Hiroo Kinoshita[1,3], Masafumi Osugi[1,3] Kazuumi Tanaka[1,3] Noriyuki Sakaya[2,3] Kazuhiro Hamamoto[2,3] and Takeo Watanabe[1,3]

1 Laboratory of Advanced Science and Technology for Industry, University of Hyogo3-1-2 Koto, Kamigori-cho, Ako-gun, Hyogo 678-1205, Japan

2 HOYA Corporation R&D Center Bldg. 3-3-1 Musashino, Akishima-shi, Tokyo 196-8510, Japan

3 CREST-JST

Phone: +81-791-58-2546, Fax: +81-791-58-2504, E-mail: kinosita@lasti.u-hyogo.ac.jp

Extreme ultraviolet lithography (EUVL) has been proposed as a next generation lithography at the 32 nm node around 2009. In the technology, defect-free mask is one of the critical issues. Consequently, we developed EUV phase-shift microscope (Figure 1) to detect such as phase-defect in multilayer mask[1)]. And we have developed the EUV beam splitter, which is critical component of phase-shift inspection or resolution enhancement. The optical system portion of an EUV microscope is shown in Figure 2. In this optics, as NA becomes different number between longitudinal and tangential direction, resolution decreases in one direction. However, by installing EUV beam splitter above Schwarzschild optics, NA becomes uniform for all planar direction and resolution improves (Figure 3).

Figure 4 shows fabrication process of EUV beam splitter[2)]. In this process, stress control is important at depositing multilayer. We controlled by changing of RF power, DC power, and the Ar working pressure. We could fabricate multilayer of low tensile stress by counteracting tensile stress of molybdenum film and compressive stress of silicon film.

Figure 5 shows the exposure results of elbow pattern of 300 nm in size. Before installing beam splitter, lines of vertical direction could not be resolved(a). However, after installing beam splitter, the 300-nm L＆S elbow pattern for all planar direction(b) has been clearly resolved. Figure 6 shows the close up of these patterns in horizontal(a) and vertical(b) directions.

We have developed an EUV microscope with a beam splitter for the first time and succeeded in the highly precise pattern inspection.

REFERENCES

1. K. Hamamoto, Y. Tanaka, S.Y.Lee, N.Hosokawa, N.Sakaya, M.Hosoya, T,Shoki, T. Watanabe and H. Kinoshita,J. Vac. Sci. Technol, B23(6), Nov/Dec (2005) 2852
2. Y. Mizuta, M. Osugi, J. Kishimoto, N. Sakaya, K. Hamamoto, T. Watanabe, H. Kinoshita SPIE 6517 (2007) 113

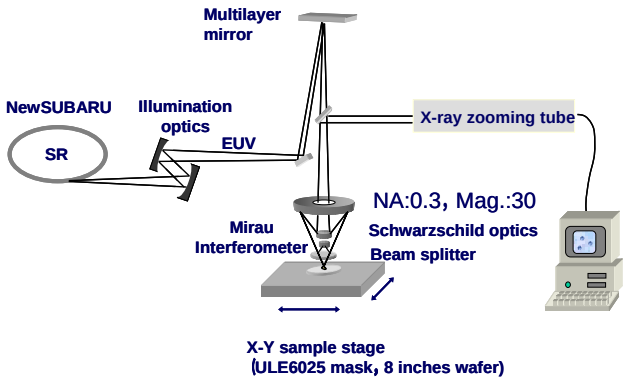


Figure 1. Configuration of EUV phase-shift microscope

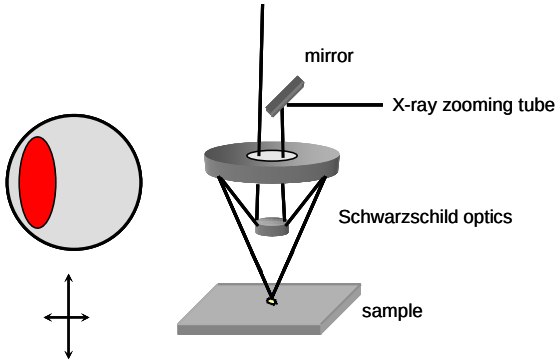


Figure 2. Configuration of Schwarzschild optics

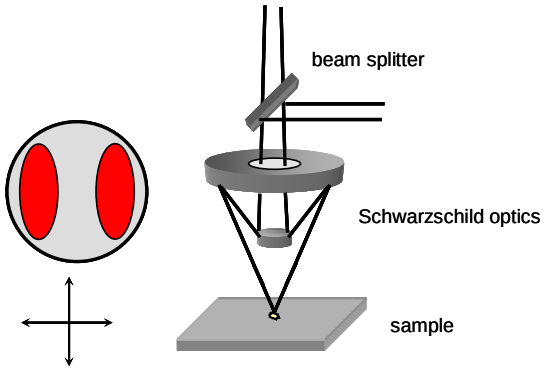


Figure 3. Configuration of Schwarzschild optics installed EUV beam splitter

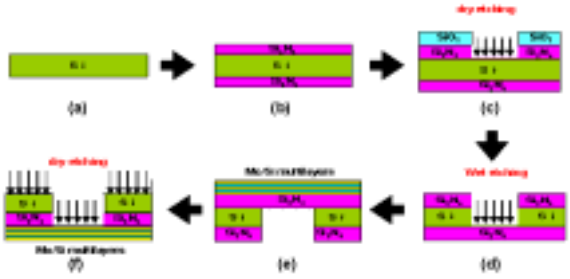
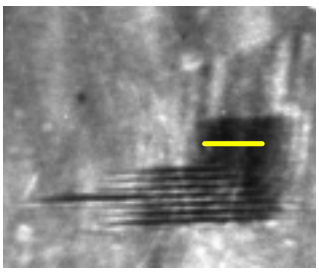
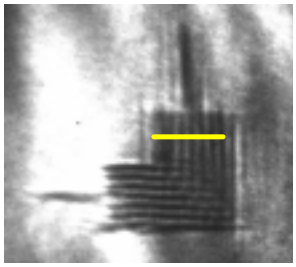


Figure 4. Fabrication process of EUV beam splitter

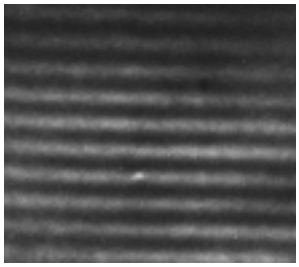


(a)Turning mirror

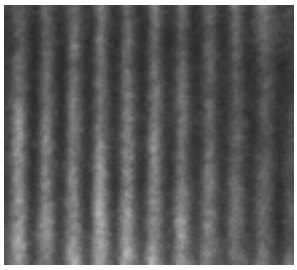


(b)Installed beam splitter

Figure 5 300-nm elbow pattern before(a) and after(b) installing EUV beam splitter



(a)Horizontal lines



(b)Vertical lines

Figure 6 Close up of Figure 5(b)