At Wavelength Metrologies for EUV Lithography

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Extreme-ultraviolet (EUV) lithography is one of the most promising printing techniques for use in the production of silicon integrated circuits with minimum feature sizes ≤ 0.07 μm [1]. EUV lithography will likely employ a multilayer-coated mask and a diffraction-limited imaging camera that reflect at 13.5 nm. Optical inspection tools can be used to find certain defects in such a mask, but an inspection tool that employs radiation near 13.5 nm is needed when attempting to locate subtle anomalies in the reflective multilayer. Similarly, advanced interferometric techniques employing visible radiation can supply the metrology needed for fabrication of an EUV camera's aspheric substrates, but the final alignment and qualification of such a camera needs to be performed at 13.5 nm because the reflective properties of the multilayer coatings can be quite different at EUV and visible wavelengths.

Three years ago, using the third harmonic from the U13 undulator beamline, we developed a phase-measuring, lateral-shearing interferometer and used it to evaluate the image quality and improve the alignment of a Mo/Si multilayer-coated Schwarzschild camera at 13.5 nm [2]. Two years ago, using the same source, we developed an inspection technique for EUV mask blanks in which a resist coated EUV transparent membrane is brought into close proximity to a reflective mask and then flood exposed with EUV radiation at 13.5 nm [3]. Both amplitude and phase defects in the reflective coating on the EUV mask blank affect the exposure of the resist and, following development, result in mounds of resist on areas of the membrane that are in proximity to defects on the EUV mask blank. Optical inspection of a membrane patterned in this way has allowed very small (0.2 μm) phase and amplitude defects in a reflective mask containing programmed defects to be located. This year, we have evaluated the possibility of replacing the 13.5-nm undulator source in these two metrology tools with a xenon capillary-discharge source. Such a source, producing an average power of 1.4 W in a π-steradian solid angle in a 0.3-nm bandwidth at 13.5 nm, has recently been developed by Sandia National Laboratories and The University of Central Florida [4]. The task of adapting the interferometric wavefront metrology technique to a xenon discharge source appears to be straightforward, but adapting the mask metrology technique to this source is difficult because the much reduced source coherence limits the maximum useable gap between the reflective mask and the resist-coated membrane. The development of a lateral-shearing interferometer employing a compact extended EUV source would be of great practical importance to a lithography tool maker for the final alignment of an EUV camera since to be useful such a tool would need to be located in-house. Similarly, the development of a mask inspection tool with a compact efficient EUV source would be of great practical importance to a mask shop, since it also would need to be located in-house and to operate in a particulate free (Class 10) environment as well.

References:

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