Overview of EUV Mask Metrology

Bryan J. Rice[1], Frank Goodwin, Vibhu Jindal

SEMATECH, 257 Fuller Rd, Albany, NY 12203
[1] Intel Assignee to SEMATECH

ABSTRACT

Extreme ultraviolet (EUV) lithography is the successor to optical lithography and will enable advanced patterning in semiconductor manufacturing processes down to the 8nm half pitch technology node and beyond. However, before EUV can successfully be inserted into high volume manufacturing a few challenges must be overcome. Central among these remaining challenges is the requirement to produce "defect free" EUV masks.

Since 2003, EUV mask blank defects have been reduced from 10000 of size greater than 100nm to about a few tens at size 70nm. Unfortunately, today's state of the art defect levels are still about 10 to 100 times higher than needed. Closing this gap requires progress in the various processes associated with glass substrate creation and multilayer deposition. That process development improvement in turn relies upon the availability of metrology equipment that can resolve and chemically characterize defects as small as 30 nm.

SEMATECH's Mask Blank Development Center has been working since 2003 to develop the technology to support defect free EUV mask blanks. Since 2009 the defect reduction efforts have included an intense focus on inspection and characterization. The facility boasts nearly $100M of metrology hardware, including an FEI Titan TEM, Lasertec M1350 and M7360 tools, an actinic inspection tool (AIT, see Figure 1 for an image), AFM, SPM, and scanning auger capabilities.

This paper will describe SEMATECH's efforts to develop robust inspection of EUV mask defects. We will discuss the development of hardware and procedures for inspecting particles 70nm and smaller. Chemical characterization techniques will be described, including approaches to TEM imaging of mask lamella (see Figure 1) that have high yield as well as scanning auger analysis of 30nm defects. The talk will conclude by describing efforts to develop future hardware, including novel approaches to fund such infrastructure development.

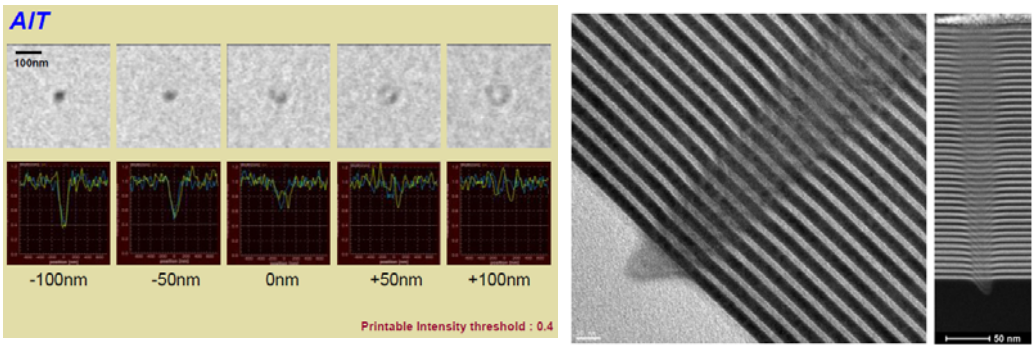

FIGURE 1. Shown here are images from SEMATECH Actinic Inspection Tool at Lawrence Berkeley National Laboratory (left) and TEM images from SEMATECH's FEI Titan installed at the College of Nanoscale Science and Engineering at the University at Albany.