Native Blank Defect Analysis for the Study of Printability

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Because extreme ultraviolet (EUV) patterning appears feasible using currently available EUV exposure tools, many researchers are focused on defect printability studies. In these studies, the mask blank defects and patterned mask defects are usually correlated with the defects printed on the patterned wafer. Although the dimensions of defects on the surface of the substrate, blank, and absorber can be characterized using atomic force microscopy (AFM), realistic characterization of the native phase defects cannot be easily done without knowledge of defect-induced changes in the structure of the deposited multilayer. Many have tried to predict the phase effects of multilayer and substrate defects based on simple growth models or measured transmission electron microscopy (TEM) multilayer deformation shapes, combined with software that calculates the electromagnetic field. These calculations have typically not been experimentally verified.

In this paper, we describe the characterization of native phase defects, which are those created during the manufacturing of EUV mask blanks, using state-of-the-art unique mask metrology in the EUV Mask Blank Development Center at SEMATECH. This study focuses on changes in the multilayer structure due to the presence of defects. TEM is used to study the changes, while SEMATECH's actinic inspection tool (AIT) is used to image defects and predict their printability. Defect images in the AIT at different focal depths will be correlated to TEM cross sections of the multilayer and AFM dimensions of the defects on top of the multilayer. The realistic characterization of the multilayer formation by TEM analysis distinguishes this investigation from previous studies, which were based on the assumption of Gaussian-shaped defects and a conformal uniform multilayer film structure.

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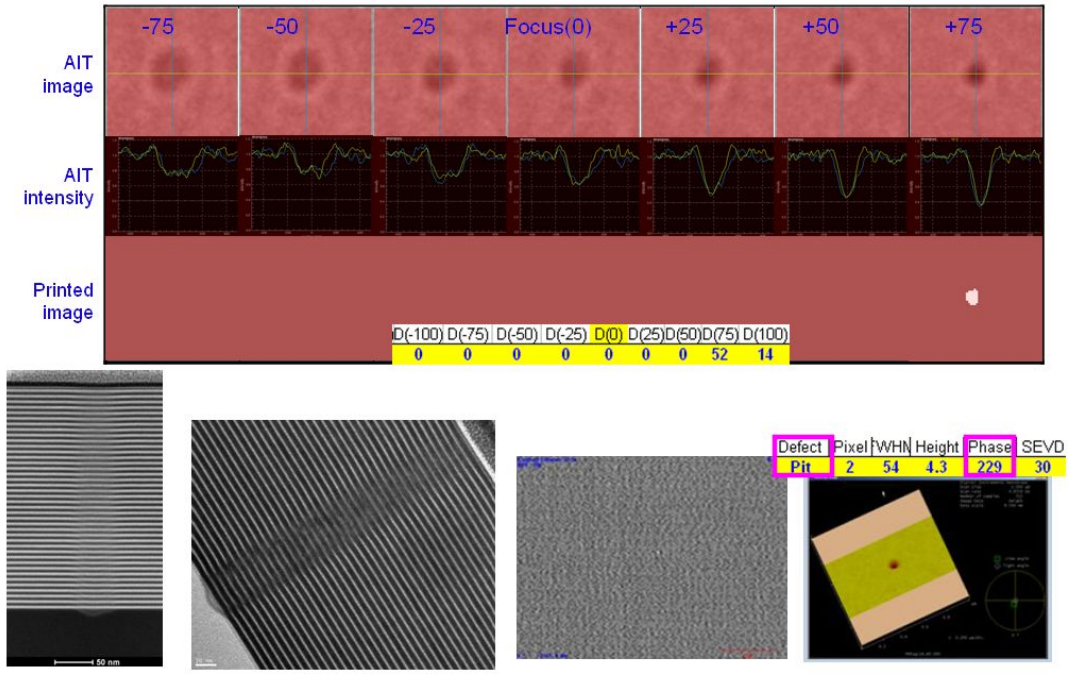
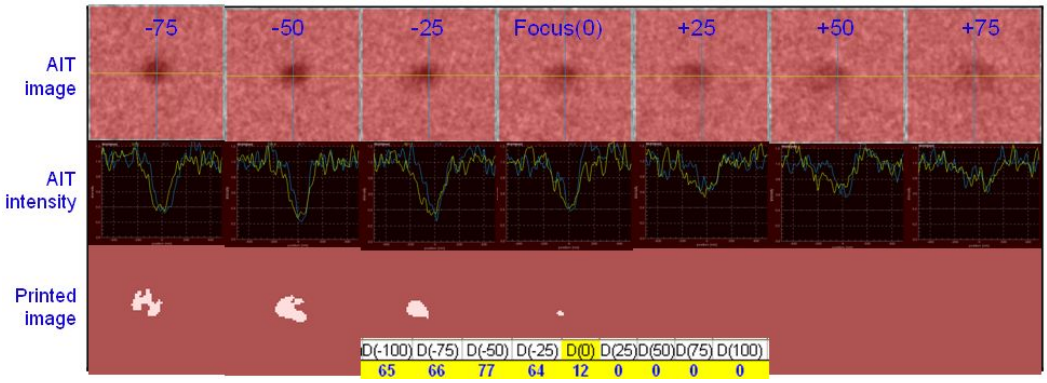


(a)



(b)

Figure 1 : Defect images. (a) Pit defect images. The defect is printed at + focus region. (b) Pit defect images. The defect is printed at – focus region.