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Publication Date

2010-11-30

Native Blank Defect Analysis for the Study of Printability

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ABSTRACT

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 to 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 are typically devoid of experimental verification.

In this paper, we describe the characterization of native phase defects, those created during the manufacturing of EUV mask blanks, using of 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, those were based on the assumption of Gaussian-shaped defects and a conformal uniform multilayer film structure.

EUV blank defects consisting of different materials and sizes that originated from the substrate or the deposition process will be investigated. The relationship between AIT image intensity and decorated defect images of specific dimensions will be reviewed. An electron-dispersive spectroscopy (EDS) study of the native particle defects will be used to correlate defect printability with defect composition. This study will throw further light on the correlation between defect printability and defect topography and enhance our understanding of EUVL technology

Keywords: EUVL, Blank Mask Blank Defect, AIT, Defect Analysis, TEM

This work was supported by the Director, Office of Science, of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.