Electron Beam Lithography Tools for Low Cost Inspection of Extreme Ultraviolet Lithography Masks

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Extreme Ultraviolet Lithography (EUVL) is the primary candidate for extending projection lithography to 22nm half-pitch features and beyond. With an illumination wavelength of 13.5nm, the theoretical resolution limit of the technology is less than 10nm. Since EUVL typically uses 4x reduction optics, feature sizes on the mask are falling below 50nm. The manufacture of high resolution, defect free EUVL masks at these dimensions is an important challenge and the authors present a method to use the backscatter detector of an electron beam lithography (EBL) tool to perform low cost defect analysis on EUVL masks.

The current state of the art for defect detection and inspection of EUVL masks relies on expensive inspection tools containing actinic EUV microscopes or scanning electron microscopes (SEMs). EUVL masks are patterned using EBL tools that can operate in an SEM mode and are designed to visit locations on the substrate with high precision. This makes EBL tools capable of performing useful EUVL mask defect inspection, potentially reducing the need for a separate inspection tool. This can potentially lower the cost and time to manufacture EUVL masks significantly. The authors present a method to perform EUVL mask defect detection using a Vistec Lithography VB300 EBL tool.

The VB300 contains a backscatter electron detector that is used to collect SEM images during the course of normal operation of the tool. It locates and measures focus marks on the substrate holders for focus and stigmation calibrations, and finds alignment marks on the substrate itself. The authors demonstrate that this ability to capture and store SEM images of the substrate, such as those shown in Figure 1, can be combined with the machinery for visiting exposure sites to capture high resolution, low distortion images for comparison to the designed pattern, such as that shown in Figure 2.

This study uses patterns defined in gold on silicon wafers to develop an initial defect detection system that captures SEM images of the pattern and compares them to design data. These substrates are used for preliminary work due to the high backscatter signal ratio between gold and silicon which simplifies the comparison. The technique is demonstrated using chrome on glass (COG) masks for 193nm lithography and the authors propose that a similar method using a secondary electron detector is viable for defect detection on EUVL masks.

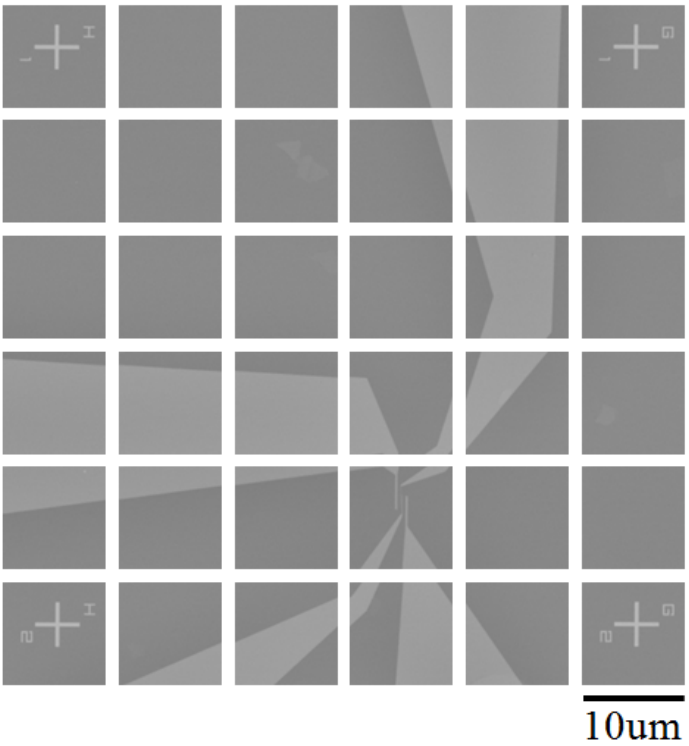

Figure 1: SEM image of pattern in gold on silicon taken with VB300 backscatter detector.

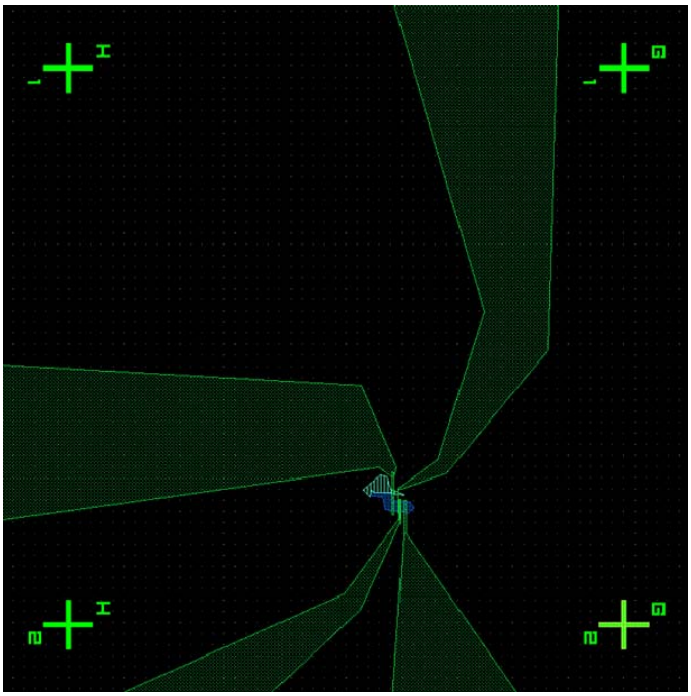

Figure 2: GDSII pattern data corresponding to the area imaged in Figure 1.