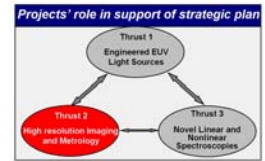


Nanoscale Imaging of Integrated Circuits

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Abstract

As the dimensions of integrated circuits continue to decrease in size, new metrology tools that can inspect the nanoscale patterns and features need to be developed. In this project we implemented a compact zone plate imaging tool using as illumination source a 46.9 nm laser. The microscope can render images in transmission and reflection mode with a unsurpassed spatial resolution. In addition it is very versatile, as it incorporates a visible imaging system that allows the user to pre-select the area of interest to image at a higher magnification with the 46.9 nm light. Image acquisition is all automated through control software developed for the system. This is the highest resolution table-top microscope at this wavelength ever reported.

Motivation



Large Scale Imaging System

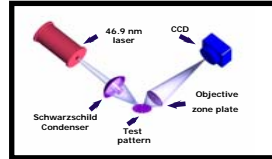


Table-top Imaging System

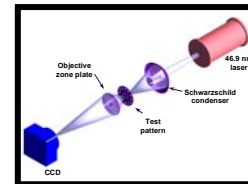
Advantages of Table-top Imaging System

- Will allow industrial manufacturers to view samples throughout the photolithography process, in their own facilities
- Cost of a table top imaging system will be significantly reduced in comparison to synchrotron facilities
- Investigated sample requires little preparation
- Sample does not need to be conducting
- Short exposure times
- Sample's environment can be varied, e.g. apply electromagnetic field

System Setup



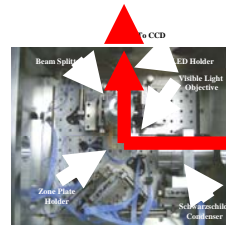
Microscope operates in both reflection and transmission mode



Thinnest layer of material absorbs EUV radiation →

Reflective and Diffractive optics

Improvements from Previous Work



Optical components inside microscope chamber

- **Compact laser:** reduced coherence effects: tested, performance is optimum for imaging
- **Schwarzschild condenser:** improved throughput
- **Zone Plate:** better spatial resolution will be obtained with outer zone width of 70 nm
- **Visible Microscope:** aids in positioning of sample; redesigned for better performance
- **Chamber Design:** ease of switching between reflection and transmission operation modes
- **Automation system:** controls all components (i.e. motors, multiple CCD cameras, pulse generator)

Future Work

- Obtain zone plates with smaller outer zones to increase spatial resolution
- Continue to reduce exposure time
- Image new samples
- Continue progress to make imaging system more industry-friendly
- Improve user interface to make work flow smoother

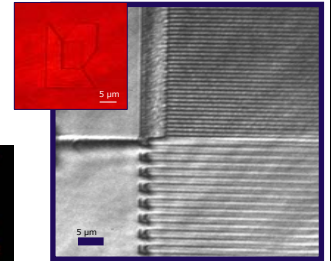
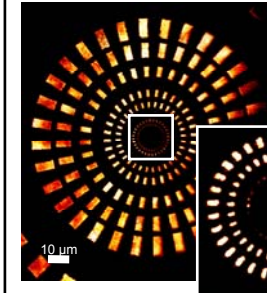
Acknowledgments

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Results

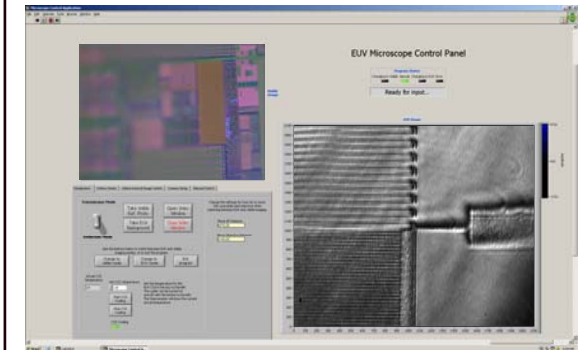
Images obtained in both transmission and reflection mode

Test Pattern in Transmission Mode



Test Pattern in Reflection Mode

Automation System



All aspects of microscope control combined into one user interface:

- Motion Controls
 - Manual
 - Automatic presets
- Visible Image acquisition
- EUV image acquisition
- Pulse generator