



Resist Outgassing and Exposure using the Energetiq EQ-10 Electrodeless Z-Pinch EUV Light Source

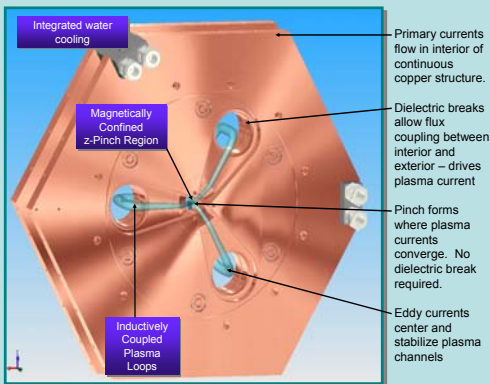
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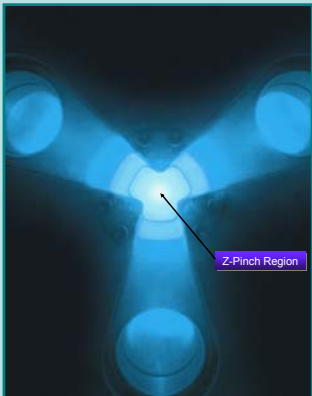
ABSTRACT

Formulating high sensitivity and high resolution EUV Resists is the most critical issue gating the adoption of EUV lithography. The ability for the resist manufacturers to quickly screen the outgassing rates and the sensitivity of EUV resists can facilitate faster formulation of a production-ready EUV photo resist. We will present results from standalone tools for resist outgassing and exposure that has enabled screening of EUV resists. The systems integrate with the EQ-10 Electrodeless Z-Pinch EUV light source. We will show data from systems which exposes multiple areas on resist coated wafers with 13.5nm in-band (+/- 3%) EUV light. The 10W EUV source allows exposure time of the order of 1 minute using a simple plane multilayer mirror and pumped and purged beam-line. During exposure, GC-MS or RGA can be used to capture the outgassing of the test resist. Since accurate determination of resist sensitivity and outgassing rates require accurate dose control, we will show results from the EQ-10 demonstrating the repeatability and accuracy of the dose control.

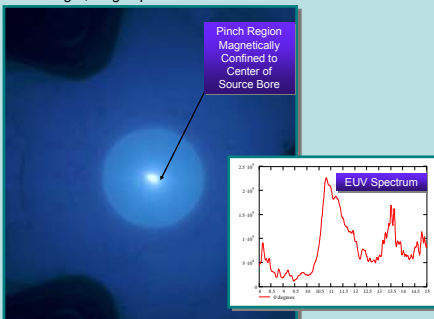
Electrodeless Z-Pinch™ EUV Source



Visible Light from Plasma

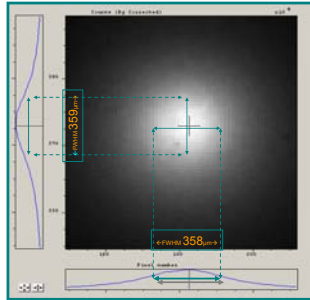


Visible light, long exposure



EUV SOURCE CHARACTERISTICS

Small, High-Brightness Plasma

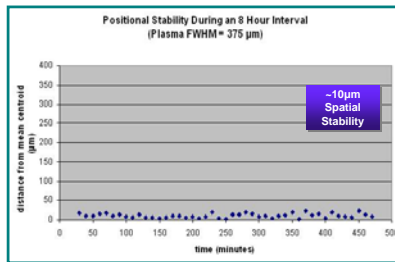


Plasma size is controlled by adjusting Xe gas pressure.

EUV source may be optimized for highest power or highest brightness depending on application

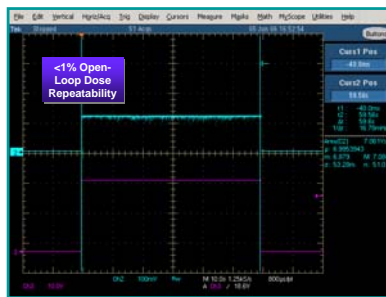
For typical, high-brightness conditions, plasma diameter is ~360µm

Long-Term Spatial Stability



Long-term spatial stability was measured using an in-band EUV camera. Images were captured every 10 minutes for 8 hours. The centroid of each image was analyzed and the distance from the mean position plotted. No special attempt was made in mechanical or vibration isolation. The mean position stability was ~10µm

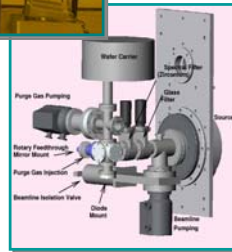
Open-Loop Dose Repeatability



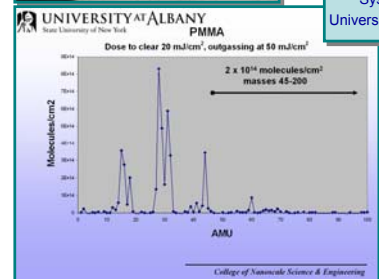
Open-loop dose stability was measured. The EQ-10 output passed through a shutter. The shutter open time was 60 seconds and the dose was analyzed for 50 60-second bursts. The source operated 'open-loop'. The dose variation (σ/μ) was 0.76%



RESIST EXPOSURE



RESIST OUTGASSING



CONCLUSION

Electrodeless Z-Pinch EUV Source has been shown to be a practical source of EUV for controlled EUV Resist screening in outgassing and frame-exposure experiments.

Dose stability and spatial stability contribute to repeatable results.

Acknowledgments

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