

# Laser Produced Plasma Light Source for EUVL

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## ABSTRACT

This paper describes the development of laser-produced-plasma (LPP) extreme-ultraviolet (EUV) source architecture for advanced lithography applications in high volume manufacturing. EUV lithography is expected to succeed 193 nm immersion technology for sub-22 nm critical layer patterning. In this paper we discuss the most recent results from high qualification testing of sources in production. Subsystem performance will be shown including collector protection, out-of-band (OOB) radiation measurements, and intermediate-focus (IF) protection as well as experience in system use. This presentation reviews the experimental results obtained on systems with a focus on the topics most critical for an HVM source.

**Keywords:** EUV source, EUV lithography, Laser Produced Plasma

## 1. INTRODUCTION

EUV lithography is the front runner for next generation critical dimension imaging after 193 nm immersion lithography for layer patterning below the 32 nm node; beginning in 2013 according to the International Technology Roadmap for Semiconductors (ITRS). NAND Flash and DRAM devices are expected to have the need for this manufacturing technology as soon as 2012, with pilot line system introduction starting this year (2011). The availability of high power 13.5 nm sources has been categorized as high risk and ranked as critical with other technologies requiring significant developments to enable the realization of EUV lithography. High sensitivity photoresists with good line-edge-roughness (LER) and line-width-roughness (LWR) are needed to keep the required source power within reasonable limits. Photoresist sensitivity and other light absorbing elements are the basis to derive EUV source power requirements within the usable bandwidth (BW) of 2%. Scanner manufacturers are requiring clean EUV power of 250 W at the intermediate focus (IF) to enable >100 wph scanner throughput assuming 15 mJ/cm<sup>2</sup> photoresist sensitivity. The need for a Spectral Purity Filter (SPF) increases the requirements for Raw EUV power even higher. Clean EUV Power is calculated by taking the Raw EUV power and subtracting the losses associated with the SPF and dose control. For the current sources these losses are estimated to be 35% and 20%, respectively. A scalable EUV source architecture is needed to enable the evolution of EUV lithography during the life cycle of the technology. Laser-produced-plasma (LPP) sources are expected to deliver the necessary high power for critical-dimension high-volume manufacturing (HVM) scanners for the production of integrated circuits in the post-193 nm immersion era.<sup>1,2</sup>

A schematic of a source vessel is shown in Figure 1. An HVM I source is shown in Figure 2. Eight sources have been built and are operational, four of these have been shipped to customers. As described in details previously<sup>3-7</sup>, the HVM I sources use a 5 sr normal incidence collector, tin droplets of 30 microns diameter, and a ~30 kW (average power) CO<sub>2</sub> laser. The HVM I source is shown in its inclined position of 27 degrees as it is positioned when integrated into the scanner.

# Laser Produced Plasma Light Source For Euvl Cymer

**Vivek Bakshi**



## **Laser Produced Plasma Light Source For Evl Cymer:**

**EUV Sources for Lithography** Vivek Bakshi, 2006 This comprehensive volume edited by a senior technical staff member at SEMATECH is the authoritative reference book on EUV source technology The volume contains 38 chapters contributed by leading researchers and suppliers in the EUV source field Topics range from a state of the art overview and in depth explanation of EUV source requirements to fundamental atomic data and theoretical models of EUV sources based on discharge produced plasmas DPP and laser produced plasmas to a description of prominent DPP and LPP designs and other technologies for producing EUV radiation Additional topics include EUV source metrology and components collectors electrodes debris mitigation and mechanisms of component erosion in EUV sources The volume is intended to meet the needs of both practitioners of the technology and readers seeking an introduction to the subject

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