ATONARP ASTON™

In-Situ Tin Halide Quantification for Extreme Ultraviolet Light Sources in Semiconductor Lithography

Application Brief

Introduction

As process geometries continue to shrink, a new challenge for semiconductor process manufactures has emerged. In advanced Extreme UltraViolet (EUV) lithography, a 13.5 nm wavelength light source is created by vaporizing droplets of molten Tin (Sn) with a carbon dioxide CO_2 laser, creating a plasma. The key challenges in high volume manufacturing include controlling defect levels caused by optics contamination from vaporized Tin re-deposits.

The Problem

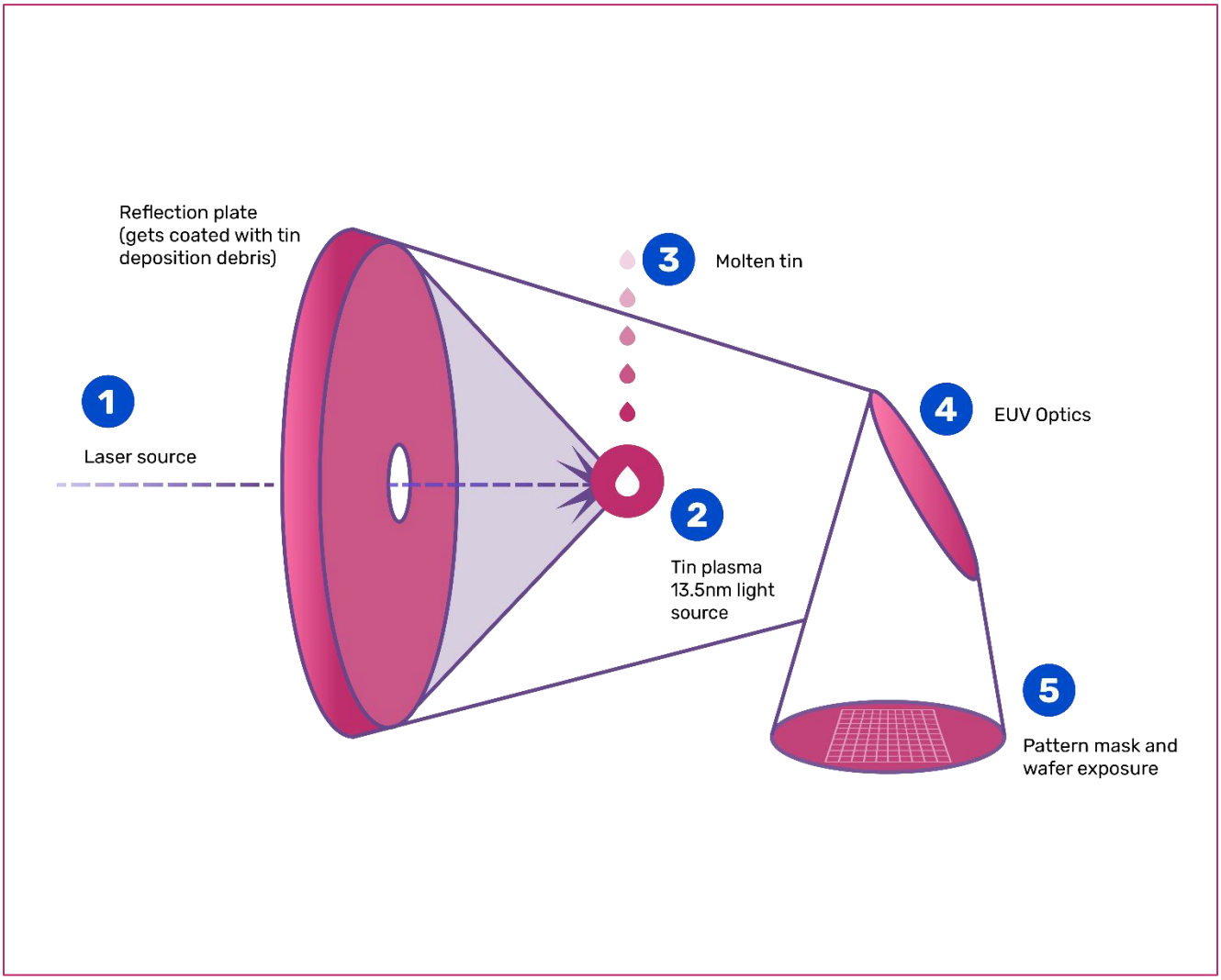
A by-product of the light source creation is tin (Sn) debris on the EUV light source reflective optics, which focuses the EUV light emitting from the plasma. Tin deposition on the coating surface of the collector mirror results in a reduction in the reflectivity of the EUV mirror. A deposited tin thickness of around 1 nm, (only several atomic layers) reduces the collector mirror reflectivity by as much as 10%, commonly regarded as the collector mirror lifetime specification. Such a contamination increases the time needed to deliver enough EUV power to pattern a wafer and therefore reduces lithography throughput and can compromise lithography pattern definition. The mitigation measures include using hydrogen plasma (combined with a magnetic field) to chemically remove tin in the form of stannane gas (SnH_4), then efficiently exhaust from the vacuum chamber, and prevent any further tin redeposition.

The Solution

Fast, accurate measurement of stannane (SnH_4) endpoint, using in-situ measurement during the reflection plate clean, ensures that tin deposits are cleared in the most time-efficient manner. Deployed on tool, Aston can measure SnH_4 at 0.01-1 ppm trace concentrations in H_2 atmosphere. Additionally, Aston can monitor the gas composition in the fore line of the EUV tool. Aston's value is in effective end point detection via monitoring the efficiency of evacuating all tin atoms from the EUV chamber and optimizing the flow of hydrogen (H_2). By minimizing gas flow the high purity H_2 consumption of 100s of standard liters per minute, can be reduced.

Summary

EUV lithography is increasingly being deployed to support critical dimension patterning for <10nm process technologies. Managing up-time and throughput of these >$200M lithography tools is critically important to FAB economics. Aston from Atonarp enables optimal reflector plate tin deposit cleaning with fast, actionable, high-sensitivity molecular diagnostic data and Aston's real time H_2 monitoring also reduces the hydrogen consumption per EUV tool.



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