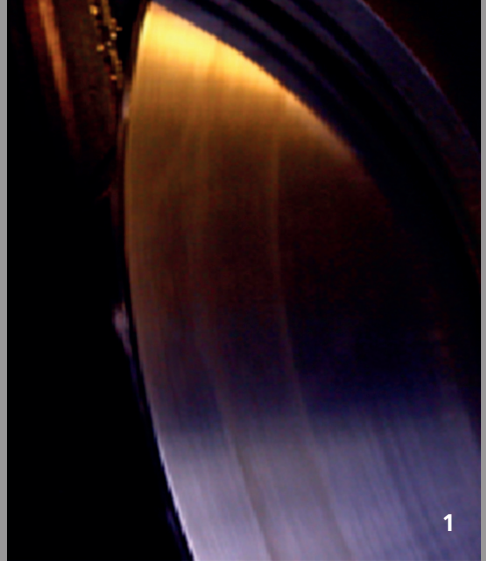

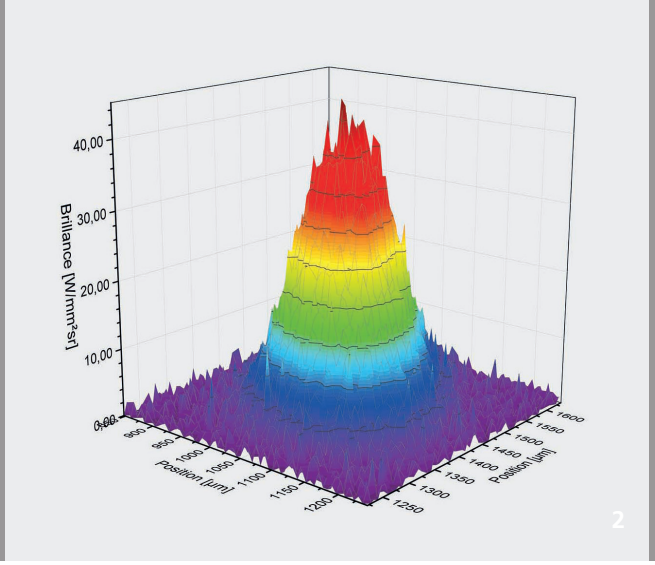

LASER INDUCED RADIATION SOURCES IN EXTREME ULTRAVIOLET

Task

Laser-induced plasmas are considered to be highly brilliant radiation sources in the spectral range of extreme ultraviolet and soft X-ray range. Here, a major technological hurdle is to provide an efficient target. The target material, which is excited by a laser pulse to emit radiation characteristic for the material, should preferably be provided in a regenerative target concept. Today, the injection of tin droplets in a vacuum chamber is a common method for radiation sources at a wavelength interesting for semiconductor production, 13.5 nm. This approach is, however, associated with considerable technological effort, especially with regard to the service life of the injection nozzle and the stability of the droplet jet.

Method

A rotating wheel wetted with liquid tin constitutes an alternative target concept. In this case a laser is focused on the constantly regenerating surface to generate a tin plasma, which emits intensive 13.5 nm radiation. This concept has already been successfully demonstrated for a discharge-based electrode system – the laser-ignited vacuum spark – from the company Ushio. The thermal budget of the wheel allows it to provide electrical power input in the range of tens of kilowatts.

1 Wheel wetted with tin as a target for laser-induced plasmas.

2 Measured beam profile at a wavelength of 13.5 nm.

Result

In a first experiment, the feasibility of this concept was demonstrated using a pulsed multi-kilohertz laser. Without further optimization of the system, an efficiency for emission of more than two percent (2πsr 2% bandwidth) at 13.5 nm could be achieved for the in-coupled laser power. The demonstrated brilliance is about 40 W/mm²sr, which would be sufficient for commercial use in mask inspection.

Applications

These highly brilliant radiation sources in the extreme ultraviolet can be used in semiconductor lithography, preferably, for example, for inspection of masks.

This work was carried out in cooperation with the company Ushio/BLV Licht- und Vakuumtechnik.

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