HHG as the Basis of High Efficiency EUV Sources
Technology #14077

Applications

- EUV Lithography

Problem Addressed

The lack of efficient EUV sources, especially at 13.5 nm (93 eV) is a roadblock for the development of EUV lithography in the semiconductor industry. The current sources for EUV lithography are either discharge produced plasma (DPP) sources or laser produced plasma (LPP) sources. For future technologies it is likely that the source power requirements will increase beyond 500W, but current source demonstrations for DPP and LPP are below 50 W. Moreover, DPP and LPP sources are not coherent, making light collection problematic and inefficient. Finally, LPP in particular has the undesired effect of producing debris, which damages source optics. These problems make LPP and DPP unfit as standard sources for the future development of EUV lithography.

Technology

The presented technology will most likely overcome these limitations. The technology uses high order harmonic generation (HHG) driven by short wavelength driver pulses (400-750 nm) to achieve EUV radiation of energies up to 100 eV. Using a specific drive wavelength and specific interaction parameters one can generate a desired EUV wavelength. The laser cavity in which the generation occurs enables the multiple interaction of the laser pulse with the gas jet. The overall efficiency of the system is determined by the number of interactions between the laser pulse and gas, so the cavity can be chosen to ensure large boosts in efficiency.

Advantages

- Generated radiation is spatially and temporally coherent which ensures precise control over wave properties
- Efficiency of system is tunable by choosing cavity with appropriate properties

Categories For This Invention:

Electronics & Circuits
Semiconductors & Integrated Circuits
Lithography
Lincoln Laboratory

Intellectual Property:

Efficient high-harmonic-generation-based EUV source driven by short wavelength light
Issued US Patent
8,704,198

**Inventors:**
Franz Kaertner
Tso Yee Fan
Kyung-Han Hong
Edilson Falcao-Filho
Chien-Jen Lai

**External Links:**
Optics Quantum Electronics Group
http://www.rle.mit.edu/oge/
Lincoln Lab
http://www.ll.mit.edu/

**Image Gallery:**

![Figure 1](image1.png)

![Figure 2](image2.png)