S22

A microplasma high-brightness EUV source at 13.5 nm

Goki Arai, Hiroyuki Hara, Yuhei Suzuki, Thanh Hung Dinh, and Takeshi Higashiguchi

Utsunomiya University, Japan

Contact e-mail: higashi@cc.utsunomiya-u.ac.jp

Abstract

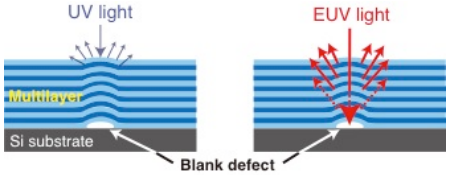
We report the effect of irradiation of solid Sn targets with laser pulses of sub-ns duration and sub-mJ energy on the diameter of the extreme ultraviolet (EUV) emitting region and source conversion efficiency. It was found that an in-band EUV source diameter as low as 18 μm was produced due to the short scale length of a plasma produced by a sub-ns laser. Most of the EUV emission occurs in a narrow region with a plasma density close to the critical density value. Such EUV sources are suitable for high brightness and high repetition rate metrology applications.

Summary

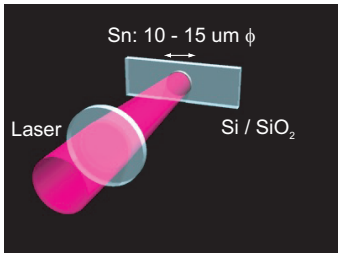
We have investigated the EUV spectra, CE, and source diameter for Sn LPPs using a Nd:YAG laser of 150-ps pulse duration and sub-mJ energy.

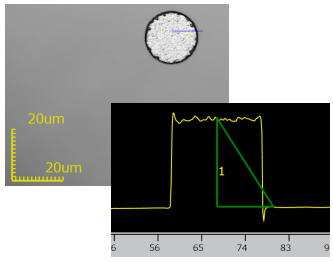
(1) CE remains almost constant for the laser energies.
(2) Small EUV source diameter of 18 μm at 0.63 mJ
(3) Compared with those from numerical simulation, and a close agreement

Background

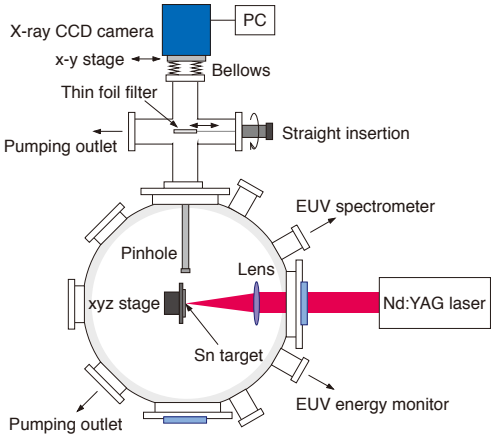


Type	Source Power (W)	Collection Angle (sr)	Source Radius (μm)	IF Power (W)	Etendue (mm²•sr)	Brightness (kW/mm²•sr)	Repetition Frequency (Hz)
HVM	720	5	100	180	1.5×10^{-1}	1.2	10×10^{3}
Metrology	10	1	10	1.5	3×10^{-4}	5	30×10^{6}

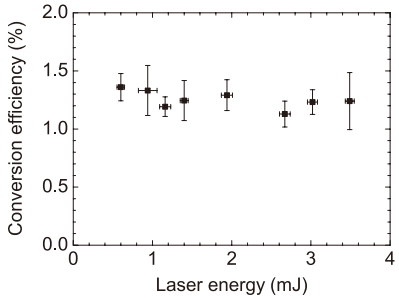




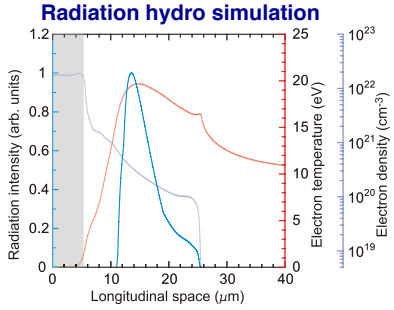
Setup & Results



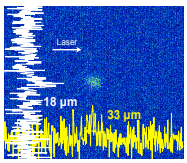
EUV CE was almost constant



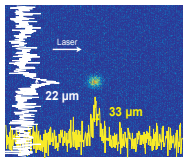
Radiation hydro simulation



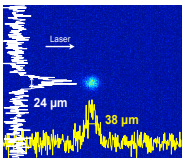
EUV source images



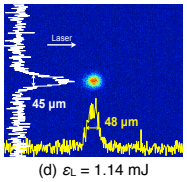
(a) ε_L = 0.63 mJ



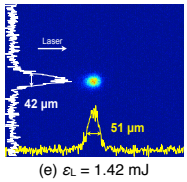
(b) ε_L = 0.75 mJ



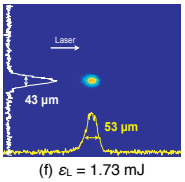
(c) ε_L = 0.79 mJ



(d) ε_L = 1.14 mJ

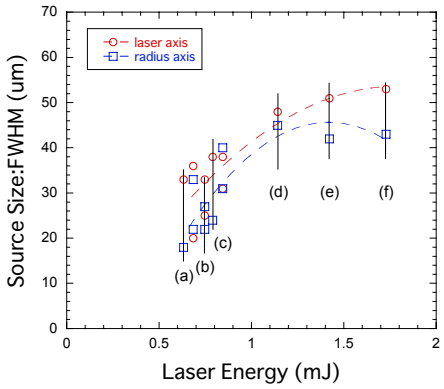


(e) ε_L = 1.42 mJ



(f) ε_L = 1.73 mJ

Source size v.s. laser energy



APPLIED PHYSICS LETTERS **105**, 074103 (2014)

Evolution of laser-produced Sn extreme ultraviolet source diameter for high-brightness source

Amitava Roy,[1,2,a)] Goki Arai,[1] Hiroyuki Hara,[1] Takeshi Higashiguchi,[1,b)] Hayato Ohashi,[3] Atsushi Sunahara,[4] Bowen Li,[5,6] Padraig Dunne,[6] Gerry O'Sullivan,[6] Taisuke Miura,[2] Tomas Mocek,[2] and Akira Endo[2]

Acknowledgements

A part of this work was performed under the auspices of Ministry of Education, Culture, Science and Technology, Japan (MEXT). We are also grateful to the Cooperative Research Center and the Venture Business Laboratory (VBL) of Utsunomiya University for providing the laser system. One of the authors (T.H) also acknowledges support from Research Foundation for Opto-Science and Technology.