

# OFI Argon Excimer Amplifier for Intense Subpicosecond VUV Pulse Generation

Masanori Kaku<sup>a</sup>, Shoichi Kubodera<sup>a1</sup>, Kazuyoshi Oda<sup>a</sup>, Masahito Katto<sup>b</sup>,  
Atsushi Yokotani<sup>a</sup>, Noriaki Miyanaga<sup>c</sup> and Kunioki Mima<sup>c</sup>

<sup>a</sup>Department of Electrical and Electronic Engineering and Photon Science Center, University of Miyazaki,  
Gakuen Kibanadai Nishi 1-1, Miyazaki, 889-2192, Japan

<sup>b</sup>Cooperative Research Center, University of Miyazaki, Gakuen Kibanadai Nishi 1-1,  
Miyazaki, 889-2192, Japan

<sup>c</sup>Institute of Laser Engineering, Osaka University, Yamadaoka 2-6, Suita, Osaka, 565-0871, Japan

A subpicosecond VUV seed beam at 126 nm has been produced by nonlinear wavelength conversion of an infrared subpicosecond laser at 882 nm in rare gases. An optical-field-induced ionization (OFI) amplifier has been optimized to amplify the VUV seed beam. The amplifier itself has produced a gain-length product of more than six by using nonlinear plasma channeling observed in a high-pressure Ar amplifier medium.

We have been developing a practical high-intensity vacuum ultraviolet (VUV) laser system driven by compact high-intensity pump lasers. A subpicosecond VUV seed beam at 126 nm has been produced by nonlinear wavelength conversion of an infrared (IR) subpicosecond laser operated at 882 nm. The characteristics of the seed beam were optimized in terms of rare gas media, their pressures, focusing geometry, pump laser intensities, and so on. The VUV output at 126 nm in Xe was much higher than that in Kr or Ar, which was explained by classical dispersion theory of those rare gases at the wavelength. The saturation of the harmonic VUV output as a function of the IR laser intensity was observed. The production of an IR laser-produced OFI plasma in rare gases may be one of the reasons to inhibit the nonlinear increase of the harmonic VUV intensity. Subpicosecond pulse measurements by use of two-photon absorption in a fluoride crystal and energy measurements are under investigation.

The low-output-power VUV seed beam should be amplified to obtain an output energy or an average power to a level of applications. We have observed and clarified amplification characteristics of an OFI Ar<sub>2</sub>\* amplifier pumped by high-intensity laser-produced electrons [1,2]. High-density, low-temperature plasma production was a key to produce Ar<sub>2</sub>\* molecules efficiently to compete with other emission processes from a plasma [3]. Control of a long Ar plasma length by using an Ar-filled optical hollow fiber or nonlinear plasma channeling together with the use of high-quality VUV optics was important to observe a small signal gain coefficient at 126 nm [2]. By using a plasma channeling observed in the Ar OFI plasma, a gain-length product of more than six was obtained at 126 nm. In this amplifier, a VUV seed beam will be amplified, which could lead to an output energy on the order of 1 μJ at 126 nm at a repetition rate of 1 kHz.

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[2] Morita Y., Higashiguchi T. and Kubodera S., *Appl. Phys. B* **82**(1), 31-33 (2006)

[3] Kaku M., Yamaura T., Higashiguchi T., Kubodera S. and Sasaki W., *Jpn. J. Appl. Phys.* **42**(6A), 3458-3462 (2003).

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<sup>1</sup> E-mail: kubodera@opt.miyazaki-u.ac.jp