MITSUBISHI ELECTRIC ANNOUNCES DEVELOPMENT OF 5.6 W 213 nm DEEP ULTRAVIOLET SOLID STATE LASER

Tokyo, February 15, 2005 – Mitsubishi Electric Corporation (President and CEO: Tamotsu Nomakuchi) announced today it developed deep ultraviolet (UV) solid state laser with 5.6 W high average power and near diffraction limited¹ beam quality at 213 nm by laser diode (LD) pumped solid state laser technology. 5.6 W of power with such a short wavelength is firstly demonstrated, which is five times higher than before. With this development, micro hole drillings would be possible on semi-conductor package with composite glass material and high density mounting board with higher quality and faster speed, and expected to accelerate the miniaturization of digital electric equipment.

This development has been conducted at Osaka University under consignment by the New Energy and Industrial Technology Development Organization (NEDO) since October 2003.

¹:diffraction limited: Minimum focused size on wavelength and Numerical Aperture of focus lens. Nearer limit means higher beam quality and microfabrication become possible.

Background

Development of diode pumped solid-state UV lasers is continuing due to there space saving and reduced maintenance properties as compared to excimer lasers. Especially, with short wavelength near 200 nm deep UV² lasers demonstrate high quality micro processing with higher absorb coefficient and less heat-affected zone. Shorter wavelength lasers have greater difficulty producing high power, and there hasn’t been any high power lasers developed for mass production at present.

We had developed diode pumped solid state lasers (1064 nm) with high power and near diffraction limited beam quality with our original uniform pumping techniques³ for less thermal distortion in laser medium, and go on with development of short wavelength solid state UV lasers for use of actual production by transforming wavelength of high power and high beam quality solid state laser beam with nonlinear optical crystals (wavelength transform element) by cooperation with Osaka University, who have own
technology for nonlinear optical crystal

2 - deep UV: Generally speaking, wavelength between 190 nm and 270 nm

3 - original uniform pumping configuration: The technique for uniform pumping solid state laser medium with trapping diode laser beam in diffusive reflector. With this technique, high bright infrared laser beams are demonstrated with highly efficient and high beam quality.

Main Features

1. **Ten times higher beam quality and scalable power amplification**
   With thin YAG laser rod, 2 mm diameter, about one third of conventional size, ten times higher focusability and high infrared pulsed laser beam with over 150 W average power are achieved by power amplification with keeping high beam quality.

2. **5.6 W average power with 213 nm deep ultraviolet laser beam**
   We designed beam propagation path, which are different for each wavelength, to minimize the temperature distribution under precise simulation of beam propagation inside crystals. With this design, by minimized temperature distribution in overlapped zone of Infrared (1064 nm) and this second harmonics (532 nm) and forth harmonics (266 nm), 5.6 W with 213 nm wavelength laser beam power generation is stably demonstrated.

3. **Success of various wavelength high power UV laser beam generation**
   By conquest of high power generation at 213 nm, which is most heat generation for crystals, we have demonstrated high power UV laser beam generation, averaging power of 43 W at 355 nm and 14.6 W at 266 nm, which are needed for micro processing of high-density mounting board.

Future Developments

Besides increasing high power, we encourage establishing the long life performance of optics including nonlinear optical crystals. Also, we plan to priority test for processing, which couldn’t be performed before for delay of laser source realization, and aim for the laser equipment for micro processing, which would be promising candidates for mass production in a short time.

Patents: 2 patents pending domestic
Configuration of high power solid-state UV laser

![Configuration of high power solid-state UV laser](image)

**Fig.1 Configuration of high power solid state UV laser**
Application example of high power solid state UV laser

For instance, following micro hole drilling laser sources for mounting board are established at once, (a) 355 nm laser source, which would be CO$_2$ substitution for faster processing of 50 $\mu$m level drilling hole, (b) 266 nm laser source, which is suited for processing of 20 $\mu$m level drilling hole and processing of glass composite, it's difficult in present, (c) 213 nm laser source, which could realize the 10 $\mu$m level drilling hole and direct hole processing for silicon substrate.

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**Fig. 2** Application example of high power solid state UV laser
Configuration of diode pumped solid-state laser

![Diagram of diode pumped solid-state laser](image)

Fig. 3  Configuration of diode pumped solid state laser

About Mitsubishi Electric
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*At an exchange rate of 106 yen to the US dollar, the rate given by the Tokyo Foreign Exchange Market on March 31, 2004.