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TECHNICAL NOTE

Beam Characteristics of a 10W Class Direct Diode Laser System for Materials Processing

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Laser beams have been considered to be one of the best tools for the thermal processing of materials, because of the ability for fine focusing of energy. However, high power lasers such as CO_2 or Nd:YAG for thermal processing are characterized by large size and low efficiency. On the other hand, diode lasers are small in size and have high efficiency, although their output power and brightness are still low. In recent years, however, high power diode lasers have been developing and reaching power levels of interest. Currently output powers of 10W and focusing diameters of 180 μ m are available. Although the beam power is still low in comparison with other lasers, we think that it is necessary to examine the characteristics of the direct diode laser for future materials processing. In this report, the beam characteristics of a 10W class diode laser for materials processing are examined.

The diode laser used was OPC-D010-910-HBPS produced by Opto Power Corp. The experimental apparatus are shown in **Figure 1**. The 12 laser beams generated in a diode bar were gathered to 1 beam in a beam shaping unit and focused on an optical fiber of 250 μ m in diameter. An Optical Re-Imaging Unit (ORU) focused the output power through an optical fiber from the diode laser module. The convergent ratio of ORU is 1:2 and the power throughput is 70%. In this report, a cover glass of 1mm thickness was set in front of the terminal glass of the ORU to prevent the contamination of the lens by spatter or mist. The output power was measured after the optical fiber, the ORU and the cover glass, respectively. **Figure 2** shows the output power dependency on the diode current. When the diode current was 35A, a maximum output power of 12W was obtained at the optical fiber output, however, it decreased to 7.5W after passing the ORU with the cover glass.

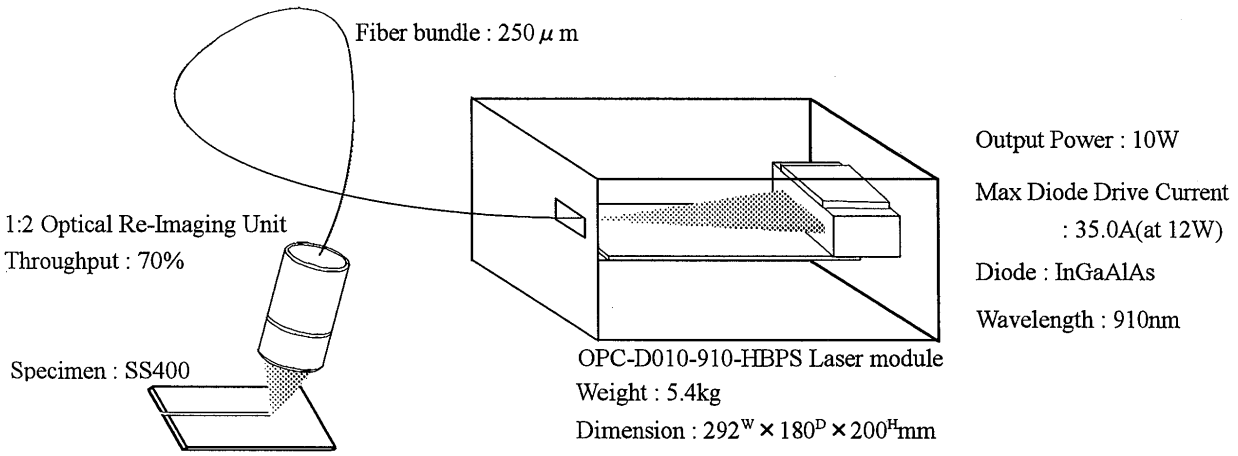

Fig.1 Experimental apparatus.

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The beam profile and the average energy density were analyzed by a laser beam analysis system UFF100 (Prometec Corp.). **Figure 3** shows the beam profile after the ORU with the cover glass. The beam diameter was 182 μ m and the mean energy density was 25kW/cm^2 at the focal point. The energy density decreased sharply with increasing work distance. The beam shape is elliptical and spread out slightly. It is thought that the shaping property of the beam shaper unit is not sufficient.

In order to investigate the possibility of direct diode laser for materials processing, cutting was performed for thin mild steel plates SS400 of 0.01 ~ 0.1mm in thickness at a focal distance of 25.6mm and cutting speeds of 2 ~ 22mm/s. **Figure 4** shows critical cutting thickness as a function of the cutting speed. A specimen of 0.06mm in thickness could be cut at an output power of 7.5W and a cutting speed of 2mm/s without surface treatment and an assist gas. The border of the cutting edge was colored black. It is thought that the laser beam has a large lower slope on the beam profile. The cutting width became wider with decreasing cutting speed. It is also thought that the focusing is not sufficient in addition to the low output power.

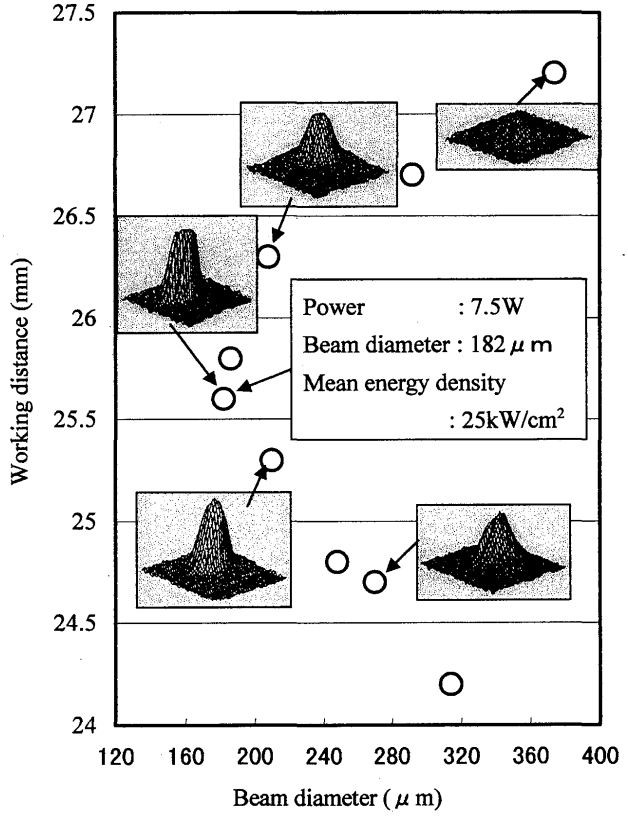

Fig.3 Beam profile of 10W class diode laser.

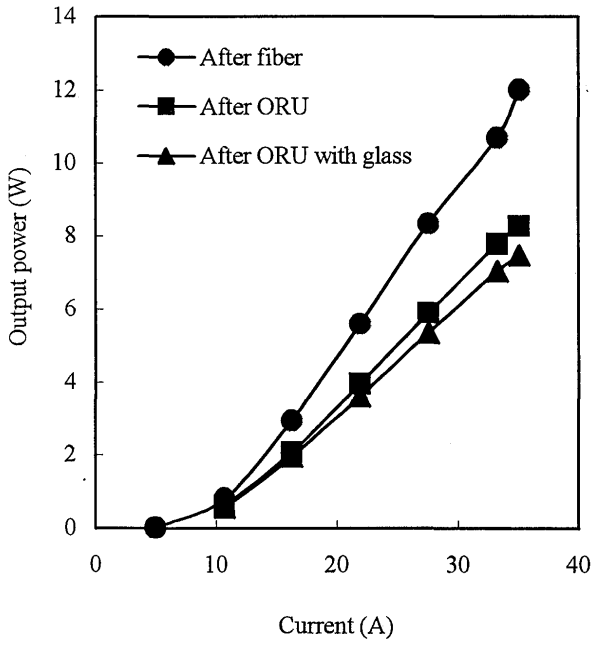

Fig.2 Output power dependency on diode current.

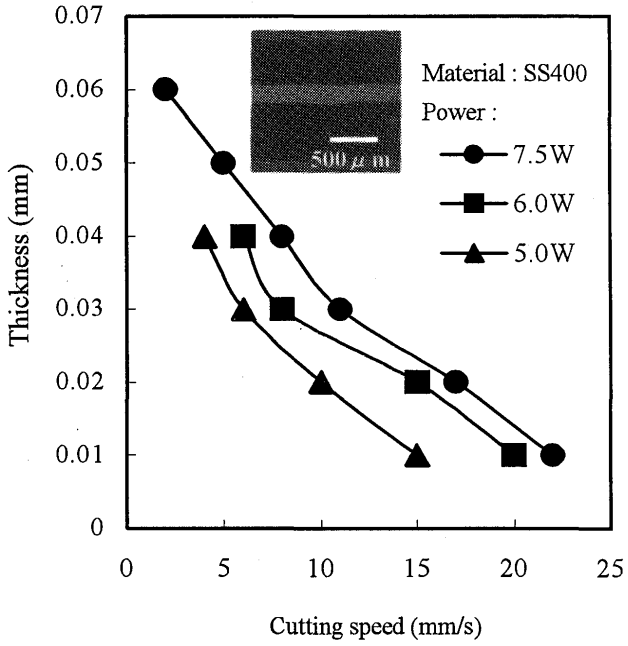

Fig.4 Cutting thickness dependency on cutting speed and output power.