A 1 kW Azimuthally Polarized CO_2 Laser

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A 1 kW azimuthally polarized laser beam is generated with a commercial CO_2 laser by employing a novel triple-axicon retroreflector unit. The technique is capable of generating radially polarized beam, too. Scalability and reliability of the proposed method is proven by the series of material processing experiments.

Radially and azimuthally polarized beams are of interest in recent years due to their unique properties. In material processing, radially polarized beam is beneficial for cutting because the beam interact with material with *p*-polarization regardless the beam sweep direction. Theoretically, that results in a twice performance comparing to the circularly polarized beam. Azimuthally polarized beam, on the other hand, is beneficial for laser drilling because the wall of the hole does not absorb the incident power thus most of them reaches the bottom. Nevertheless, such beams have not been realized for material processing until very recently because of its difficulty at high powers. Very recently, Ahmed *et al*.[1] have successfully generated a 3kW radially polarized beam using a commercial CO_2 laser and a resonator mirror with diffractive polarization selector.

We propose an alternate method to produce radially or azimuthally polarized beams. Figure 1 shows the schematic drawing. It consists of a triple-axicon retroreflector unit, and an ordinary plane output mirror. Any kind of laser medium that has a circular aperture is compatible with this resonator. Especially, solid-state media like Nd: YAG are ideal because cylindrical polarization will ease thermally induced birefringence. The principle of this resonator is explained as follows. The beam entered to the retroreflector unit reflects six times to exit. At each reflection, radially polarization is *p* and azimuthally polarization is *s*-polarization to the reflecting surfaces. Therefore, you can make the reflectivity of radially and azimuthally polarizations different by an existing multilayer coating technique. Then the oscillation modes of the laser is forced to azimuthally or radially polarized with regards to the selection of reflectivity.

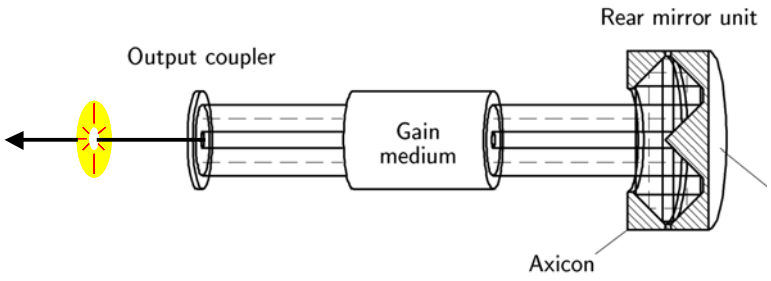

Fig. 1: Principle of the proposed resonator

We have designed a resonator for Amada OLC-2000, a 1kW-class, transverse-flow, cw commercial CO_2 laser. Originally, the mirror was designed to $r_p > r_s$, but it turned out $r_p < r_s$ by the manufacturer's fault. Figure 2 shows the result. The polarization of the output beam was measured by the linear polarizer and 2-D Spiricon beam diagnostics device. It is clearly seen that the output beam is azimuthally polarized. Stable 1.0kW output was achieved and it was enough to conduct cutting and drilling experiments. Through the series of the material processing experiments, the stability and durability of the resonator has been proven.

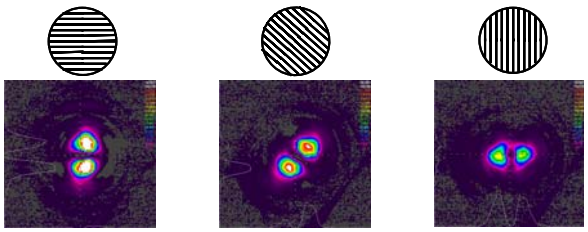

Fig. 2: Laser output passed through a polarizer

[1] M. Ahmed et al., Opt. Lett. **32**, 1824-1826 (2007)

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