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Single mode fiber laser and their process applications

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1. Introduction

Although fiber lasers have existed since the 1960s, [1] their performance evolved by leaps and bounds in the early 1990s with rapid progress of the erbium (Er) doped optical fiber amplifier (EDFA) for telecommunications. Higher power devices become possible in late 1990s using ytterbium (Yb) doped active fiber. [2-4] A single mode (SM) fiber laser with more than 1kW continuous wave (CW) average power has an excellent beam density of close to $1x10^9 W/cm^2$ once it is properly focused. This power density level is remarkably high among other CW laser technologies as shown in Fig. 1.

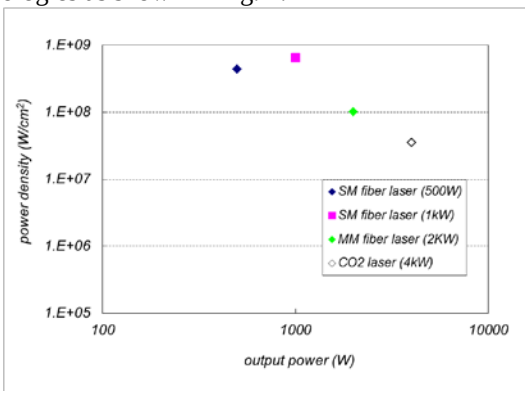

Fig.1 power density at focus in various lasers

2. Material processing using SM fiber laser

This power density, can be used in the thermal processing of almost all the metallic materials used in industry, with a melting point below 1500 °C. These processes include both cutting and welding of conventional material like steel, stainless steel and aluminium as well as high reflectivity material like copper, brass and ceramics. They are not easy to process using conventional laser like CO_2 lasers.

3. Pulsed operation and conposite material prosessing

Figure 2 is the optical configuration of single mode fiber laser. Pulsed Quasi CW operation of a fiber laser is simply realized by modulating the diode drive current, which then changes the diode power. Figure 3 shows the response of the pump diode power and SM fiber laser when the diode current is modulated. A 100kHz modulation bandwidth is achieved at fastest diode control and micro second pulse is generated from this laser.

Carbon fiber reinforced plastics (CFRP) is composite material of composed of carbon fiber and polymer resin. [5] It is not easy to establish excellent cutting quality due the large difference in melting temperature between two materials. Micro second pulsed operation is effective method to mitigate heat affective zone (HAZ), and cutting quality is improved compered to simple thermal processing.

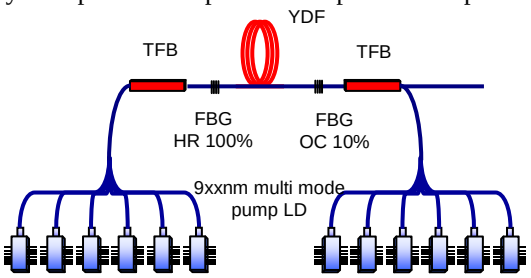

Fig.2 Optical configuration of CW Single mode fiber laser

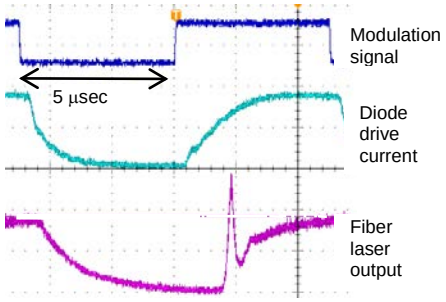

Fig.3 Time response of fiber laser when modulation

4. Conclusions

Single Mode fiber laser is becoming quite useful source for micro and macro material processing; in the most of the conventional metallic materials include high reflective materials. Laser can be also act as micro second pulse laser when directly modulated and cutting quality of CFRP is improved.

5. Acknowledgment

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6. References

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