A Review of High-Power Fiber Laser in Industry

Asma Al Ahmadi , Romain Baudoin, Giuseppe Scurria, Jawaher Al Ameri, Reem Al Ameri, Taif Al Hmoudi, Amit Dubey, Guillaume Matras, Chaouki Kasmi
Directed Energy Research Centre
Technology Innovation Institute
Abu Dhabi, United Arab Emirates
Asma.AlAhmadi@tii.ae

Abstract— High power laser systems have evolved dramatically over the years contributing to the development of new technologies in manufacturing and material processing, communication, and medicine. High Power Fiber Laser (HPFL) is a special type of laser which uses silica fiber doped with rare earth element as an active medium for light amplification. The various geometries of fiber, along with the highly directed beam and wavelength range offers a wide range of possible new industrial opportunities which makes fiber laser research an interest of the Directed Energy Research Centre (DERC) at Technology Innovation Institute (TII). The aim of this research at DERC is to obtain state of the art outputs power emitting in the near infrared range using Yb and Tm doped fibers which provides highest output power among rare-earth elements. This paper will review high power lasers in industry, high power fiber laser application and configuration. In addition to state-of-the-art facilities of DERC for fiber processing showing results and future work.

Keywords: High power, Fiber laser, beam quality, splicing

I. REVIEW OF INDUSTRIAL HIGH POWER LASER

High energy lasers played a critical role in the development of new industrial technologies including material processing like cutting, welding, drilling, and marking different materials for manufacturing purposes. The primary high power lasers used in material processing are CO_2 emitting at 10.6 µm, thin disc emitting at 1.03 µm, and fiber lasers emitting at 1-2 µm operating in both continuous mode, where a continuous beam is emitted, and pulsed mode where a highly intense pulse of laser is emitted. The shorter wavelength of thin disc and fiber laser gives them advantage over the CO_2 since shorter wavelength result in higher absorption in metals and higher wall-plug efficiency [1]. On the other hand, fiber lasers produce a higher beam quality and efficiency compared to thin disc because of its geometry. In addition, fiber laser introduces a more compact and robust design compared to the complex and costly free space design of thin disc laser [2].

II. REVIEW OF HIGH-POWER FIBER LASER

Fiber lasers offers an integrated system with high quality and robustness maintaining lower cost compared to other types of lasers. Fiber lasers are considered solid state lasers where the core of the fiber is doped with rare earth elements and pumped with laser diodes. The interest of this conference paper is Yb doped fibers at 1 µm wavelength which are popular in material processing industry and Tm doped fibers at 2 µm wavelength which are popular for soft tissue surgery, eye surgery and lithotripsy [3]. The system component consists of different architectures of an active fiber as the gain medium, laser diodes as pumping source, Fiber Bragg Gratings (FBG) as reflectors, combiners to combine the pump laser.

III. FIBER PROCESSING STATE OF THE ART FACILITIES

The aim of this research at DERC is to realize two all fiber laser platforms in a Master Oscillator Power Amplifier (MOPA) configuration which consists of two parts one for producing the beam and the second to amplify the beam using optical devices that are fiber based. In order to build an all fiber system, state of the art fiber processing system have been selected which is based on fusion splicing using CO_2 laser, graphite filament, and arc discharge heating sources providing high precision splices and low loss. Along with splicing the product series is designed to perform other several tasks including stripping, cleaning, cleaving, recoating, and proof testing. The goal is to adjust the processing system parameters to achieve high quality splices then test the quality with splice active monitoring system which uses a low power laser diode to test active and passive fibers output power before and after splicing.

REFERENCES

[1] B. Schmidt, M. Schaefer, “Advanced industrial laser systems and applications “ , *SPIE Digital Library* , volume :10525, pages:1052502, Feb 15, 2018. Accessed: Jun. 6, 2022. doi: 10.1117/12.2299534.
[2] Stefan Ruppik, Frank Becker, Frank-peter Grundmann, Wolfram Rath, Ulrich Hefter,” High-power disk and fiber lasers: a performance comparison “ , *SPIE Digital Library*, volume : 8235 , pages : 149-163, Feb 9, 2012. Accessed: Jun. 6, 2022. doi:10.1117/12.913286.
[3] Sen, Ranjan & Saha, Maitreyee & Das Chowdhury, Sourav & Shekhar, N.K. & Pal, Debasis & Ghosh, Aditi & Dhar, Anirban & Pal, Atasi & Pal, Mrinmay, “HIGH POWER FIBER LASERS: FUNDAMENTALS TO APPLICATIONS”, *ResearchGate Science and culture*. December 2015. 81. 319-326.