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3-Level Ytterbium Fiber Lasers for Efficient High-Power Lasing (2019-007)

Diffraction-limited 3-Level Ytterbium Fiber Lasers enabled by all-solid photonic bandgap fiber for efficient, high-power lasing in a variety of applications

Market Overview

This efficient three-level laser pump, enabled by an all-solid photonic bandgap fiber, increases peak powers, reduces fiber length, and enables a high efficiency rating at 976 nm wavelengths. The fiber laser market was estimated at $1,782 million in 2017, and is projected to reach $4,403 million by 2025, with growth driven by the need for data transfer, welding, cutting, marking and material processing. Fiber lasers are quickly becoming the tool of choice for a variety of applications – communications, printers, material R&D, medicine, and more, however there is a significant need for higher beam quality, lower cost, and eco-friendly technology. Clemson inventors have designed a new ytterbium fiber (Yb) laser pump for suppressing lasing at traditional Yb wavelengths to overcome current limitations and provide efficient, high-power diffraction limited lasing.

Technical Summary

Double-clad fiber is consistently used for today's high-power fiber lasers, which allows the high-power pump light with poor mode quality to be used at the cost of a significant reduction in the pump light's overlap with the active single-mode core. Consequently, much longer fiber has to be used with reduced peak powers. Further, ytterbium fiber lasers are not typically used as pump lasers, as they usually lase at wavelengths between 1025nm and 1100 nm. The all-solid photonic band fiber feature on this technology, however, enables efficient high-power diffraction limited lasing at ~976 nm. The unique design enables laser light to be launched directly into the active single-mode core, resulting in an increased overlap between the pump light and the active core within the fiber, without increasing core size or fiber length. These novel developments could increase peak powers from fiber lasers by over two orders of magnitude, in conjunction with a two-order reduction in fiber length. This benefit is significant, as the built-in distributed spectral filters are over the entire length of the fiber and are responsible for suppressing transmission in the traditional ytterbium lasing wavelengths. These new capabilities prove for the first time that high-power diffraction-limited pump is not only possible, but also highly efficient.

Application

Lasers, Manufacturing, Advanced Materials, Automotive, Engineering, Electronics, Solar Power, Telecommunications, Semiconducting, Glass Cutting

Development Stage

Prototype/Animal Studies Complete

Advantages

- All-solid photonic band fiber suppresses lasing at traditional wavelengths, increasing peak powers while reducing fiber length for higher efficiency
- Three-level system for lasing at ~976 nm without increased complexity, allowing for user-friendly operation
- Technology design can be extended to other three level laser designs, extending their operational capabilities while enhancing performance of the fiber laser system that they are intergrated into

App Type	Country	Serial No.	Patent No.	CURF Ref. No.	Inventors
Provisional	United States	62/925,966	NA	2019-007	Dr. Laing Dong Turghun Matniyaz

About the Inventors

Dr. Liang Dong

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Dr. Dong earned his B.S. in Electronics in 1985 at the Harbin Institute of Technology and his M.S. in Communication Engineering and Digital Electronics two years later from the University of Manchester Institute of Science and Technology. He received his doctorate degree in optical fibers in 1992 from the University of Southampton. Prior to joining Clemson University, Dr. Dong served as senior technical manager at IMRA America Incorporated, R&D director at Lightwaves2020 Incorporated and R&D manager at Corvis Incorporated. He also worked as senior scientist at Corning Incorporated and managed optical fiber fabrication activities at Southampton University. Dong is a fellow of OSA and SPIE and a senior member of IEEE. He has published ~300 papers in scientific journal and conference proceedings and has 27 granted patents. Dr. Dong has 30 years of experience in research and development in photonics and optical fibers for a wide range of applications including telecommunications, industrial machining, medical and sensing.

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