

激光加工用5 kW光纤耦合半导体激光器

刘友强¹, 曹银花¹, 李景¹, 邱运涛¹, 秦文斌¹, 王智勇¹, 王大勇², 杨光辉^{1,3}

1. 北京工业大学 激光工程研究院, 北京 100124;
2. 北京工业大学 应用数理学院, 北京 100124;
3. 中国人民解放军96658部队, 北京 100094

5 kW fiber coupling diode laser for laser processing

LIU You-qiang¹, CAO Yin-hua¹, LI Jing¹, QIU Yun-tao¹, QIN Wen-bin¹, WANG Zhi-yong¹, WANG Da-yong², YANG Guang-hui^{1,3}

1. Institute of Laser Engineering, Beijing University of Technology, Beijing 100124, China;
2. College of Applied Sciences, Beijing University of Technology, Beijing 100124, China;
3. Troop 96658, the Chinese People's Liberation Army, Beijing 100094, China

摘要

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摘要

针对国内大功率半导体激光光纤耦合存在的问题,设计了光纤耦合聚焦系统,研制了5 kW光纤耦合半导体激光器。比较了常见圆光斑光纤耦合与半导体激光方光斑光纤耦合的区别;对国产阵列型半导体激光堆栈,采用光束质量均匀化、偏振合束、多波长合束多路耦合等方式增加能量,将激光耦合进芯径为800 μm,数值孔径(NA)为0.2的传能光纤中,实现了光纤耦合半导体激光输出光功率5 109 W,光纤耦合效率85.69%,系统整体电光转换效率49.48%;在聚焦镜焦距为250 mm时其激光功率密度达到 2×10^5 W/cm²,可以用于金属的表面重熔、合金化、熔覆和焊接等领域。该激光器除了传能光纤外,其余部件均为国产和自主研发,对我国国产大功率光纤耦合半导体激光器的开发具有重要的推动作用。

关键词: 激光加工, 半导体激光器, 光纤耦合, 激光焊接, 激光熔覆

Abstract:

To overcome the shortcomings of the optical fiber coupling of a domestic higher power diode laser, an optical fiber coupling focusing system was designed and a 5 kW optical coupling diode laser was developed. The optical fiber coupling methods by common circle spot and diode laser squarespot were compared. For a domestic array diode laser stack, the optical quality homogenization, polarization beam bunching, multi-wavelength bunching were used to increase the energies, by which the laser can be coupled into the optical fiber with a core diameter of 800 μm and a Numerical Aperture(NA) of 0.2. Thus, the fiber coupled output power reaches 5 109 W, the fiber coupling efficiency is 85.69%, and the electro-optic conversion efficiency of overall system is 49.48%. Moreover, the power density reaches 2×10^5 W/cm² when focal length is 250 mm. The laser has been used in multi-wavelength surface remelting, metal alloying, laser cladding and laser welding fields. All the parts of the laser are made in China except the optical fiber for energy transfer, so it promotes the progress of higher power domestic optical fiber coupling lasers.

Key words: laser processing diode laser fiber coupling laser welding laser cladding

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作者简介: 刘友强(1982-),男,山东潍坊人,博士后,2014年于北京工业大学获得博士学位,主要从事高功率半导体激光技术及光纤耦合技术的研究。E-mail:liuyouqiang@bjut.edu.cn;曹银花(1964-),女,吉林长春人,副研究员,硕士生导师,2005年于北京理工大学获得博士学位,主要从事大功率半导体激光光束控制与光纤耦合技术的研究。E-mail:caoyh@bjut.edu.cn

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