Amplification of a radially polarized beam in a thermally-guiding fiber-rod amplifier

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250 Word Abstract

Laser and optical amplifier geometries may be split into categories such as rod and fiber. Rod gain media are susceptible to thermal effects at high power, whereas fiber suffer from detrimental non-linear effects due to their long length and small mode areas. Here we present an application of a hybrid architecture between the two geometries – the Thermally-Guiding Fiber-Rod (TGFR). The TGFR inherits the large mode area of the rod amplifier, the high surface area of a fiber, and exploits thermal lensing to guide modes.

We present a successful demonstration of amplification of a radially polarized mode using the TGFR. A 1030 nm continuous-wave radially polarized seed source of high purity and beam quality (M^2=1.9±0.1) was constructed using thermal bifocussing in a Yb:YAG crystal to provide mode selection. This seed source was carefully focussed into the 300 µm core of a 10 cm long sample of commercially available triple-clad Yb-doped silica fiber in order to satisfy the thermal guidance condition and avoid waveguiding due to the refractive index step. The TGFR was pumped using a high power 915 nm diode laser.

The radially polarized mode was preserved through transmission of the TGFR. The output beam polarization was maintained at 99.1% purity while the M^2 factor was measured to be 2.1±0.1. The maximum output power was 12.6 W of radially polarized light, corresponding to a gain of 7.0 dB limited by available pump power. This promising geometry the potential for further power scaling of radially-polarized beams for application in laser processing.

100 Word Abstract

We demonstrate the use of a Thermally-Guiding Fiber-Rod (TGFR) to amplify a radially polarized seed beam. The TGFR combines advantages of fibre geometries for excellent thermal management and rod geometries for avoidance of detrimental non-linear effects. It exploits thermal lensing to guide modes, which along with its symmetry lends it particularly well to application in amplifying axially-symmetric higher-order modes. A high purity radially polarized seed source was amplified by thermally guiding the mode through the 300 µm core of a triple-clad Yb-doped silica fiber. The polarization and beam quality were preserved while achieving a 12.6 W output and 7.0 dB single-pass gain.