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Amplification of structured light in end-pumped solid-state amplifiers

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Structured light beams from the Laguerre-Hermite-Gaussian mode families with scalar or vector polarization structures have found applications in many diverse areas, particularly in high dimensional quantum communication, optical particle trapping and super-resolution microscopy. However, only a small subset of these structured beams, namely, the radially and azimuthally polarized annular modes, have been applied in the laser materials processing industry. The full spectrum of scalar and vector polarized structured light modes are easily accessible through devices such as the Spatial Light Modulator (SLM's) and Digital Micromirror Devices (DMD's), but due to their low-power handlining ability, direct generation at high power (>100W) is not possible. We propose a system that performs beam shaping (Gaussian -> Structured Mode) at low power with subsequent amplification to high-power using the Master Oscillator Power Amplifier (MOPA) strategy while preserving the complex spatial, phase and polarization properties of the beam. In this work, we explore amplification of vector and scalar polarized structured beams selected with a spatial light modulator using a detailed analytical model developed for double-pass end-pumped MOPA architecture. We demonstrate stable output power from the amplifier system and confirm the preservation of the beam characteristics using the modal decomposition and vector quality factor characterization techniques. This novel work will form part of an intermediate step towards the realization of Killo-watt level structured light beams for application in industrial laser material processing.

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

PhD

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