Structured Light Generation in Multicore and Multimode Fiber Amplifiers

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Abstract: We discuss recent advances in the efficient and controllable generation of structured beams in multicore and multimode fiber amplifiers through the use of a reflective phase-only spatial light modulator as an in-line beam shaping element.

Summary

The generation of structured light beams with exotic spatial intensity, phase and polarization profiles has attracted ever increasing research interest over the past decade, and has resulted in the development of novel techniques for a wide range of applications, including the optical manipulation of particles/cells, quantum/optical communications, imaging and materials processing. Various techniques have been developed to date for the creation of such beams directly from laser sources. However, it is still a major challenge to develop efficient, compact and robust laser sources capable of flexibly generating structured light beams on demand and at practical output power levels. Here we introduce recent progress on the generation of such beams in multicore fiber (MCF) and multimode fiber (MMF) amplifiers.

Our technique relies on a reflective phase-only spatial light modulator (SLM) as an adaptive in-line beam shaping element placed directly before the MCF or MMF amplifier. The SLM provides the capability to adaptive shape the wavefront of the input beam and hence to accurately control the amplitude, phase and polarization state of the amplified light at the MCF or MMF output. We experimentally demonstrated the generation of various spatial modes within the continuous-wave and pulsed operation regimes supported by the MCF and MMF, including linearly polarized (LP) scalar modes, and arbitrary spatial modes represented on the 1st and 2nd higher-order Poincare sphere (HOPS) such as optical vortex beams and cylindrical vector beams. This architecture enables the generation of high-purity, used-defined structured beams at power well beyond the power handling limits of the SLM.