

Efficient multi-spot and quasi-Bessel beam generation using all-fibre structure for advanced material processing

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We present a novel approach for generating multi-spot laser beams using an all-fibre structure, specifically designed for material processing applications. By utilizing multimode interference in single mode fibre – square core fibre structures, we demonstrate a highly efficient method to produce multi-spot beams arranged in a square lattice configuration (e.g. 2×2, 3×3, 4×4 beams). This fibre-based solution eliminates the complexity of free-space optics while enabling precise beam manipulation, significantly enhancing the versatility of high-power fibre laser systems. Our approach is validated through both simulations and experiments, producing beam profiles that are well-suited for advanced manufacturing processes, such as laser drilling in metals. Furthermore, we explore single mode fibre – multimode fibre structures to generate quasi-Bessel beams, providing a robust solution for applications requiring non-diffractive, high-intensity beams. These results establish a solid foundation for the advancement of next-generation fibre-based laser systems in material processing technologies.

[1] Yongmin Jung et al., “Efficient multibeam generation in square lattices using SMF-SCF structure,” SPIE Photonics West, 12871, 66-69, 2024.

[2] Yongmin Jung et al., “Multispot fiber lasers for material processing applications,” SPIE Photonics West, 12865, 56-60, 2024.