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Design of Single-Mode Fiber-Coupling Lenses and Tolerance Analysis

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Abstract

As the key component in applications like optical communications, high-beam-quality fiber lasers, etc., single-mode fibers are of great importance due to their guidance of the single-mode field. For such applications, it is relevant to investigate how to launch light into, and collect light from, the fiber efficiently. Unlike in the design of traditional imaging lens systems, the fiber coupling efficiency calculation requires knowledge of the matching between the fiber mode field and the field in the focal region of the coupling lens. Especially for high-NA situations, the possible vectorial effects must also be considered in the calculation, and therefore, a fully physical optics model is necessary for the design of coupling lenses. Additionally, we perform a tolerance analysis of some given coupling lenses, in terms of fiber-end shift and tilt, based on physical optics as well.