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Chalcogenide Glass Optical Fibers for High-Resolution Mid-Infrared Image Transport

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Abstract: Image fibers, which transport spatial images directly, are widely used in medical endoscopy and inspection of harsh environments, but commercial fibers are designed for visible light and cannot effectively transport images in the mid-infrared (MIR, 2.5-25 μm). MIR light carries unique information unavailable from visible light: it enables label-free molecular imaging through vibrational fingerprints, and, since the thermal emission peak of the human body lies near 9.3 μm, non-contact thermal imaging. Conventional silica-based image fibers, however, suffer from poor MIR transparency and severe inter-core crosstalk. In this work, we design and fabricate a chalcogenide image fiber (Ch-IF) for high-resolution MIR image transport. As_2S_5 and $AsSe_2$ glasses, whose refractive index dispersions were precisely determined by a combined minimum-deviation and interferometric method, are used as the cladding and core, respectively. A 199-core fiber arranged on a triangular lattice with three different core diameters is designed by finite-element simulation to suppress crosstalk through propagation-constant mismatch, and fabricated accordingly. The resulting Ch-IF achieves MIR image transport at 9.3 μm with a spatial resolution exceeding 25 line pairs/mm, more than five times higher than previously reported MIR image fibers, demonstrating a promising route toward in-situ label-free molecular and thermal imaging.

Keywords: *Chalcogenide glass, mid-infrared image fiber, crosstalk suppression, high-resolution imaging*