



GRIN Aberration-Correction Probe Based on a Metalens

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Experience:

Name of School	Academic degree	Duration (from/to)
College of Optical Sciences, University of Arizona	Ph. D	2004/08~2008/09
College of Optical Sciences, University of Arizona	M.S.	2004/08~2007/06

Affiliation	Title	Period
Current Position:		
Institute of Medical Device and Imaging	Professor	2018/08~Present
Former Position:		
Institute of Medical Device and Imaging	Associate Professor	2015/08~2019/07
Molecular Imaging Center	Division Chief	2012/01~2017/07
Opti-electronic Biomedical Research Center	Assistant Professor	2011/08~2015/07
Mechanical Engineering, MIT, USA	Postdoctoral Associate	2008/12~2011/07

Market Needs:

This technology targets the market for miniaturized imaging systems and probes, particularly for endoscopic and catheter-based imaging (e.g., OCT) and inspection in confined spaces. The primary needs are to maintain high resolution and high contrast under very small probe diameters and limited packaging lengths, while reducing aberrations—especially astigmatism—that degrade lateral resolution and introduce image distortion. Additional needs include improving assembly tolerance, manufacturing consistency, and cost effectiveness. Existing solutions based on GRIN optics or multi-element micro-lens stacks are often limited by insufficient aberration-correction capability, high sensitivity to alignment, and increased system size and cost. Accordingly, there is clear market demand for an aberration-corrected optical module that remains compact while being manufacturable and packaging-friendly.

Our Technology:

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This invention proposes a GRIN (gradient-index) lens as the primary miniaturized focusing/relay element, combined with a metalens whose phase profile is engineered for wavefront shaping, forming a GRIN-metalens hybrid aberration-correction probe/module. Through co-design of the GRIN lens numerical aperture (NA), working distance, and the metalens phase distribution and placement (e.g., bonded or spaced configuration, distal tip integration), the approach compensates dominant system aberrations and suppresses astigmatism. As a result, it improves the point spread function (PSF) and lateral FWHM, enhances image contrast and effective coupling efficiency, and reduces optical-stack complexity and improves packaging feasibility without significantly increasing the overall form factor.

Strength:

Compared with conventional multi-element micro-lens or aspheric stacking approaches, this technology leverages the design freedom of metalens phase engineering to provide system-level aberration correction in a highly miniaturized form. Key advantages include a more compact footprint, fewer optical components, rapid design customization for different working distances/NA/bands, and potential scalability to manufacturing with improved uniformity via micro-/nano-fabrication routes. In addition, the invention supports multi-layer IP positioning, including claims on structure/system, design and calibration methods, and packaging/alignment features, thereby strengthening defensibility.

Competing Products:

Competing solutions include GRIN-only probes, miniaturized lens modules that correct aberrations by stacking multiple spherical/aspheric micro-lenses, and wavefront-shaping architectures that combine diffractive optical elements (DOE) or phase plates with conventional lenses. Under high-NA and small-diameter packaging constraints, these approaches commonly face limited aberration-correction capability, high alignment sensitivity, and increased volume or cost. Some MEMS-scanning integrated probes emphasize scanning functionality, yet their optical aberration correction typically still relies on conventional lens stacking or limited corrective elements.

Intellectual Properties:

Our research team has decades of experience in the fields of metasurfaces and microscopy, and has published several related international journal articles.

Contact (do not need to fill out):

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