

Silicon Carbide Optoelectronic and Photonic Device Integration

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Abstract— Silicon Carbide (SiC), as a third-generation semiconductor material, emerges as an ideal platform for advancing nanophotonic technologies due to its high refractive index, low optical loss, compatibility with integrated circuit processes, and high thermal conductivity.

This talk presents key innovations in SiC photonics. First, to overcome the critical issue of focal shift in high-power laser processing caused by thermal absorption in traditional objective lenses, we designed and fabricated a 4H-SiC metalens that rivals commercial objectives. Its outstanding thermal management enables stable, near-diffraction-limit focusing performance during extended operation. Second, addressing challenges in metalens design such as the sensitivity and unpredictability of in-plane topology optimization algorithms, limitations in degrees of freedom, and the computational burden of full-wave simulations, we utilized an inverse design optimization algorithm to develop a metalens with both high numerical aperture (NA) and achromatic characteristics.

Furthermore, to solve the problems inherent in conventional full-color display diffractive waveguide AR glasses, specifically their bulk and weight from multi-layer waveguides, rainbow artifacts induced by ambient light, and thermal management challenges in micro-optical engines, we designed and mass-produced an ultra-lightweight, ultra-thin SiC AR waveguide. This device employs a single-layer waveguide to achieve full-color display and a large field of view (FoV), while effectively suppressing rainbow artifacts.

These studies provide innovative solutions for designing ultra-compact optical devices and are poised to accelerate the development and practical application of high-performance SiC nanophotonic devices.

Prof. Min Qiu is the Guoqiang Chair Professor of Optical Engineering and Vice President at Westlake University, where he also serves as the Dean of School of Engineering and the Director of Westlake Institute for Optoelectronics. He is a Member of Academia Europaea and a recipient of the National Science Fund for Distinguished Young Scholars. He is also a Fellow of several prestigious professional societies, including: IEEE Fellow, Optica Fellow, SPIE Fellow, etc. He currently serves as the Editor-in-Chief for PhotoniX (Springer Nature), the Associate Editor for Science Bulletin (Science China Press), the Associate Editor of Acta Photonica Sinica, etc.

Prof. Qiu's main research interest is micro-nano optoelectronics, including micro-nano fabrication technology and instrumentation,

micro-nano photonics theory and optoelectronic devices, key theories and technologies for smart applications, etc.

