Light Science & Applications

# Multimode silicon photonics for large-scale integration

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In recent years, multimode silicon photonics beyond the singlemode regime is becoming extremely attractive because the introduction of multimode photonic waveguides brings tremendous opportunities for the development of large-scale photonic chips. In this paper, we give a review for recent progresses of multimode silicon photonics and the applications. of the first part is to show monomode light propagation in multimode photonic waveguides for ultra-low-loss and low-phase-error on-chip light propagation, providing the physical fundamental to enable significant performance improvement of various representative photonic devices, such as low-loss optical delaylines, high-Q optical resonators, low-crostalk arrayed-waveguide gratings, calibration-free Mach-Zehnder interferometer switches, and calibration-free high-order microring resonator filters, which are very useful for large-scale photonic integration. The second part it to demonstrate the realization of large-scale silicon photonic integration. Finally, we give an outlook for the challenges and the opportunities for the future development of multimode silicon photonics.

**Short Bio:**

**Daoxin Dai** received the B. Eng. degree from the Department of Optical Engineering of Zhejiang University in 2000 and obtained his Ph. D. degree from the Royal Institute of Technology (KTH), Sweden, in 2005. He joined Zhejiang University as an assistant professor in 2005 and became an associate professor in 2007, a full professor in 2011. He worked at the University of California at Santa Barbara as a visiting scholar in 2008-2011. Currently he is the QIUSHI Distinguished Professor at ZJU and is leading the Silicon Integrated Nanophotonics Group. He has developed multimode silicon photonics and silicon-plus photonics for enabling high-performance silicon photonic devices and large-scale photonic integrated

circuits, including ultra-low-loss silicon photonic waveguide delaylines, ultra-high-Q silicon photonic resonators, ultra-low-crosstalk arrayed-waveguide gratings, FSR-free multimode waveguide grating filters, calibration-free photonic switches, 2Ч2 FP cavity optical modulators, record-high gain-bandwidth-product Ge/Si avalanche photodiodes, digitally-tunable dispersion controllers, etc. He has published more than 300 international journal papers at Science, Nature, Nature Photonics, Nature Communications, Light: Science & Applications, Optica, Laser & Photonics Reviews, etc. Prof. Dai is one of Most Cited Chinese Researchers (Elsevier) and has given >100 plenary/keynote/tutorial/invited talks at prestigious international conferences. He is the Winner of National Science Fund for Distinguished Young Scholars (2017), Wang-Daheng Award of Optics (2020), the first-class Natural Science Award of Zhejiang Province (2020), the first-class Award of Optics of Chinese Optical Society (2020). He has severed as a general co-chair of ACP 2022, OECC 2023, etc. Currently Prof. Dai is the Dean of the College of Optical Science and Engineering and the Chair of Optical Society of Zhejiang Province, and he has been elected as Optica (former OSA) Fellow in 2021.