Silicon chip propels 6G communications forward

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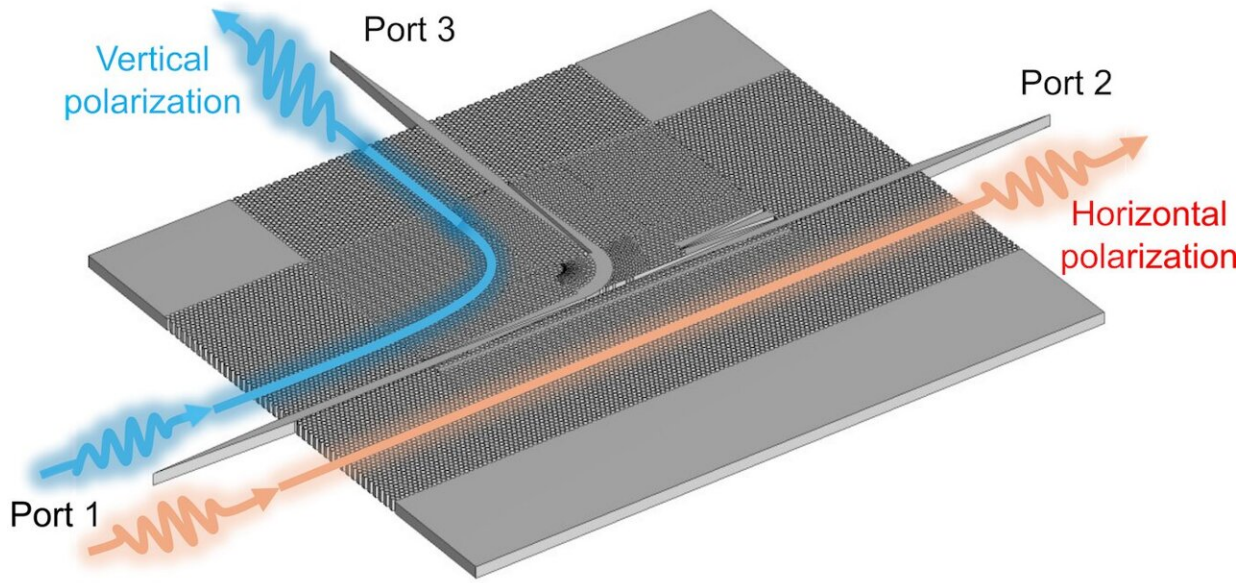

Operation schematic of the proposed all-silicon terahertz integrated polarization (de)multiplexer. Credit: Dr. Weijie Gao / Osaka University

A team of scientists has unlocked the potential of 6G communications with a new polarization multiplexer. Terahertz communications represent the next frontier in wireless technology, promising data transmission rates far exceeding current systems.

By operating at terahertz frequencies, these systems can support

unprecedented bandwidth, enabling ultra-fast wireless communication and data transfer. However, one of the significant challenges in terahertz communications is effectively managing and utilizing the available spectrum.

The team has developed the first ultra-wideband integrated terahertz polarization (de)multiplexer implemented on a substrateless silicon base which they have successfully tested in the sub-terahertz J-band (220–330 GHz) for 6G communications and beyond.

The University of Adelaide's Professor Withawat Withayachumnankul from the School of Electrical and Mechanical Engineering led the team which also includes former Ph.D. student at the University of Adelaide, Dr. Weijie Gao, who is now a postdoctoral researcher working alongside Professor Masayuki Fujita at Osaka University.

"Our proposed polarization multiplexer will allow multiple data streams to be transmitted simultaneously over the same frequency band, effectively doubling the data capacity," said Professor Withayachumnankul. "This large relative bandwidth is a record for any integrated multiplexers found in any frequency range. If it were to be scaled to the center frequency of the optical communications bands, such a bandwidth could cover all the optical communications bands."

A multiplexer makes it possible for several input signals to share one device or resource—such as the data of several phone calls being carried on a single wire.

The new device that the team has developed can double the communication capacity under the same bandwidth with lower data loss than existing devices. It is made using standard fabrication processes enabling cost-effective large-scale production.

"This innovation not only enhances the efficiency of terahertz communication systems but also paves the way for more robust and reliable high-speed wireless networks," said Dr. Gao.

"As a result, the polarization multiplexer is a key enabler in realizing the full potential of terahertz communications, driving forward advancements in various fields such as high-definition video streaming, augmented reality, and next-generation mobile networks such as 6G."

The challenges addressed in the team's work, which they have published in the journal *Laser & Photonic Reviews* significantly advance the practicality of photonics-enabled terahertz technologies.

"By overcoming key technical barriers, this innovation is poised to catalyze a surge of interest and research activity in the field," said Professor Fujita who is a co-author of the paper. "We anticipate that within the next one to two years, researchers will begin to explore new applications and refine the technology."

Over the following three-to-five years, the team expects to see significant advancements in high-speed communications, leading to commercial prototypes and early-stage products.

"Within a decade, we foresee widespread adoption and integration of these terahertz technologies across various industries, revolutionizing fields such as telecommunications, imaging, radar, and the internet of things," said Professor Withayachumnankul.

This latest polarization multiplexer can be seamlessly integrated with the team's earlier beamforming devices on the same platform to achieve advanced communications functions.

More information: Ultra-wideband terahertz integrated polarization

multiplexer, *Laser & Photonics Review* (2024). DOI: 10.1002/lpor.202400270

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