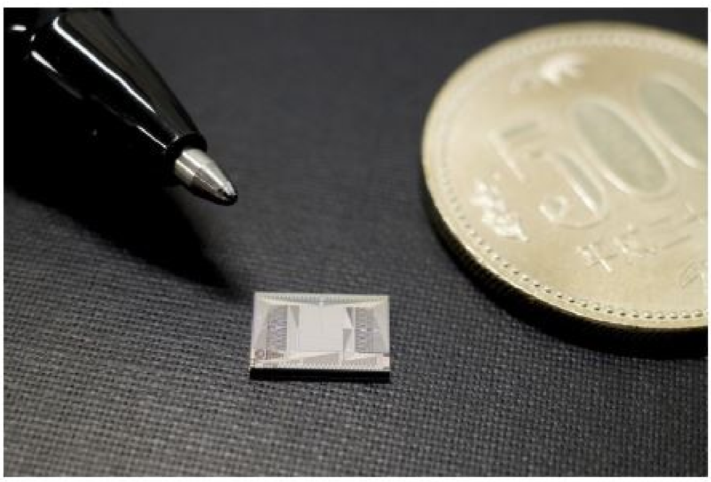
Slow-Light Waveguide Provides Beam-Steering Capabilities for Lidar

YOKOHAMA, Japan, Jan. 21, 2020 — In the field of lidar, where speed is often valued above other variables, a team from Yokohama National University is using "slow light" to develop compact, easy-to-use, 3D sensors with nonmechanical beam-steering capabilities.

"Currently existing optical beam-steering devices all use some kind of mechanics, such as rotary mirrors," professor Toshihiko Baba said. "This makes the device large and heavy, with limited overall speed and a high cost." Optical phased arrays can be used to direct the optical beam without mechanical parts, but this approach requires a large number of optical antennas and each antenna needs to be calibrated.

For its nonmechanical approach to beam-steering, the Yokohama team used a photonic crystal waveguide aimed through a silicon-etched medium. When light was forced to interact with the photonic crystal, it slowed down and was emitted to free space. The researchers used a prism lens to then direct the beam in the desired direction.



A small-size silicon photonic chip that could be used for nonmechanical beam-steering and scanning. Courtesy of Yokohama National University.

The lattice-shifted photonic crystal waveguide maintained slow light as a guided mode and worked as an optical antenna when the researchers introduced a kind of double periodicity. The researchers selected one photonic crystal waveguide from an array and converted the fan beam to a spot beam using a collimator lens to allow for nonmechanical, two-dimensional beam steering. A shallow-etched grating made into the photonic crystal waveguide was used as the double periodicity, increasing the upward emission efficiency. The team designed a bespoke prism lens to convert the steering angle in a desired direction, while maintaining the collimation condition for the steered beam.

The resulting device is small and free of moving mechanics, and could form the foundation for a solid-state lidar device that would be smaller, less expensive to make, and more resilient than conventional lidar systems.

Next, Baba and his team plan to more fully demonstrate the potential of a solid-state lidar and will work on improving the performance of their system, with the ultimate goal of commercializing the device.

"The nonmechanical steering is thought to be crucial for lidar sensors," Baba said.

The research was published in *Optica*, a publication of The Optical Society (OSA) (www.doi.org/10.1364/OPTICA.381484).