FY2016

Development of High-Resolution LIDAR System Based on Slow-Light Structures

Slowing the speed of light brings innovation to conventional technology

Light travels so fast that it goes around the Earth some 7.5 times per second. Being able to make full use of "slow light" technology that significantly lowers the speed of light allows different light-related functions, such as modulation, switching, wavelength conversion, detection, dispersion compensation, correlation, and beam scans, to become increasingly sophisticated.

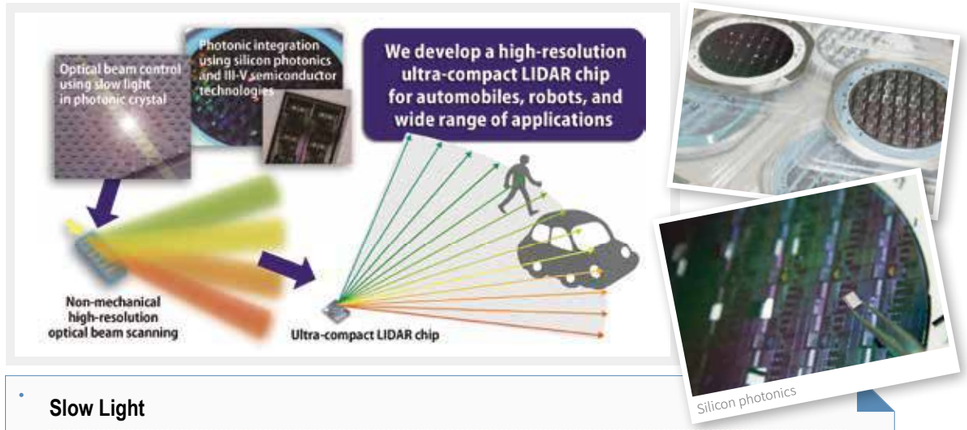
We are working on R&D for this slow light technology using photonic crystals,* and so far have established its fundamental theory and demonstrated its basic operation. Under special environments, such as extremely low temperatures, it is known that the speed of light can be reduced down to the speed of a bicycle. Instead of employing such extreme deceleration, our slow light technology has succeeded at room temperature, or under similar easily usable environments, in lowering light speed by around one-tenth to one-hundredth on a small semiconductor chip. As a result, we are producing world-leading results on research to improve the sophistication of the functions described above.

* A mosaic structure with period of around half a light wavelength. This freely controls the behavior of light by fully exploiting light's wave-like property.

Towards the realization of LIDAR (Light Detection and Ranging) that can recognize surroundings in three dimensions and at high resolution

In the ACCEL project, as an application of slow light technology, we will develop and realize LIDAR that can recognize an object in three dimensions by precisely measuring the distance and direction of the object using reflected light. The project will develop a high-resolution, non-mechanical optical beam steering device,* and we intend to build and demonstrate a compact and low-cost LIDAR system incorporating this scanner. The design and fabrication techniques developed during the project are expected to bring about a significant evolution in optoelectronics and related fields.

* A device that changes the direction of light. It is used as a beam scanner in LIDAR. A non-mechanical type is desirable as the standard mechanical types are bulky and may become unstable or break due to vibration when installed in vehicles.



Slow Light

Lightwaves with different wavelengths, when superimposed, will interfere each other, and the parts in phase provide increases light intensity. This part is called the pulse. When all wavelengths move at the same speed, the pulse moves at the same speed. However, if the speed depends on the wavelength, the pulse will slow down. This pulse speed is called the group velocity, and light with an extremely slow group velocity is called slow light.

Research Director

Toshihiko Baba

Professor, Graduate School of Engineering, Yokohama National University

If the speed of light slows down to one-tenth, its interactions with the environment become ten times larger. If this property is applied to an optical device, its performance will be improved ten-fold. While it also becomes ten times harder to handle, however, this has been mitigated by recent technological advancement, and slow light devices are now ready for practical use. This is why this ACCEL project has chosen slow light and LIDAR as themes. I am engaged in the research while consulting with Dr. Kobayashi about his wealth of experience with commercialization. He has been active at the forefront of optical device development since I was a student.

The ACCEL project experimentally produces LIDAR chips incorporating optical beam scanners at an LSI factory. Through multiple discussions in parallel with the prototype production, we will determine the properties necessary for commercialization. Our ultimate goal is to achieve LIDAR chips that stand out for being ultra-compact, high-resolution, vibration-resistant, and low-cost productivity.

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Program Manager

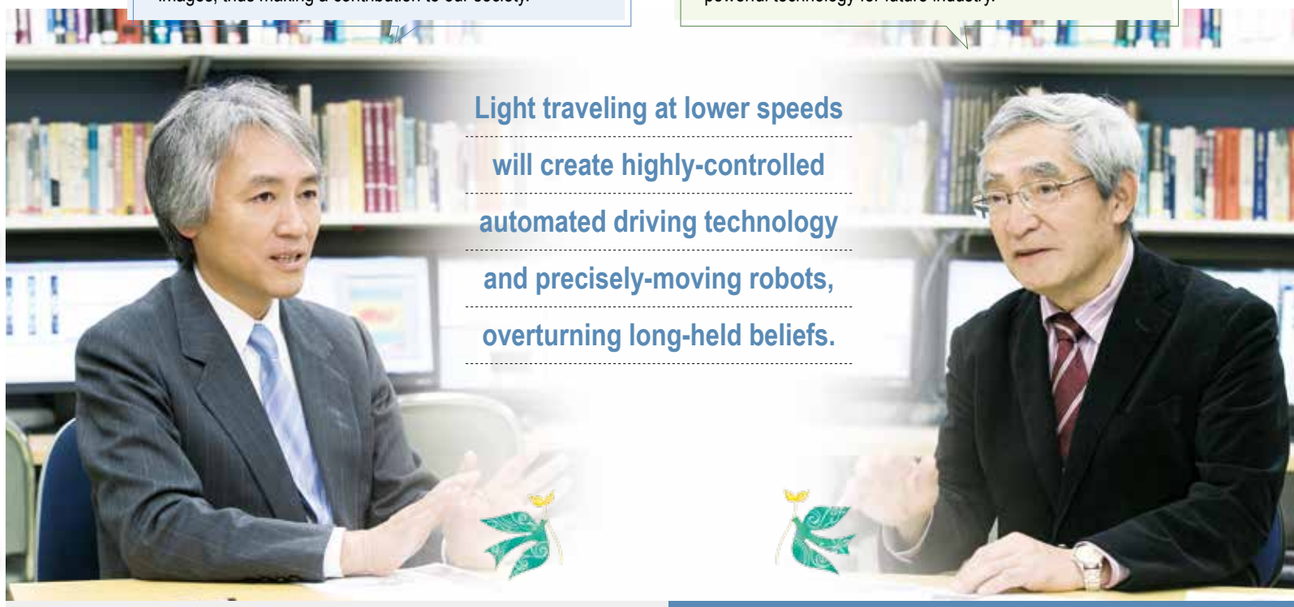
Kohroh Kobayashi

ACCEL Program Manager, Japan Science and Technology Agency

The application of developed technologies to society requires three important elements: technology, people, and hardware. "Technology" means world-leading original technology such as slow light. "People" are the basis for the relationship of trust needed for successful technology transfer. "Hardware" means that the technology to be transferred will be passed along not only as written documents but also as tangible objects.

In this ACCEL project, as Program Manager I will support the research team led by the research director, Professor Baba, in the promotion of commercialization through linking research and industry. I visited several dozen Japanese and American companies to hold hearings and make proposals right back at the program preparation stage. I will also hold conferences with the industrial sector on LIDAR as needed. LIDAR is a field where there are a lot of expectations for technological advances and market expansion. I would like to participate in the project not only for the joy of being part of the commercialization of this world-leading fundamental research but also to enjoy it as a difficult challenge.

As a sensor indispensable for automated driving technology and high-performance robots with artificial intelligence, LIDAR has the possibility to become the most powerful technology for future industry.



Light traveling at lower speeds will create highly-controlled automated driving technology and precisely-moving robots, overturning long-held beliefs.

PROFILE — TOSHIHIKO BABA

1990: Ph.D. (Engineering), Yokohama National University. Joined Tokyo Institute of Technology; 1993: Yokohama National University; in current post since 2005. Fields of expertise: Optical engineering, photon science. Research into photonic crystals, nanolasers, Si photonics, biosensors, functional photonic devices and optical circuits that use them.

PROFILE — KOHROH KOBAYASHI

1970: M.S. (Electronic Engineering), Tokyo Institute of Technology. Joined NEC Corporation; worked for Tokyo Institute of Technology and FiBest Limited. Experience with optical device R&D and commercialization, especially semiconductor lasers for optical communication. Ph.D. (Engineering)