Press release

May 7, 2026
Keio University

Plastic Optical Fiber (GI POF) Demonstrates 212.5 Gbps Transmission Over 50 m for Next-Generation Data Centers

A research team at Keio University (President: Kohei Itoh), led by Project Professor Yasuhiro Koike, Director of the Keio Photonics Research Institute (KPRI), and Project Senior Assistant Professor Kenta Muramoto, both at the Keio Frontier Research & Education Collaborative Square (K-FRECS) at Shin-Kawasaki, has developed a graded-index plastic optical fiber (GI POF) for higher-speed short-reach optical interconnects and successfully demonstrated next-generation single-lane transmission at 212.5 Gbps (gigabits per second) over 50 meters.

With the proliferation of generative AI, the volume of data exchanged within data centers is growing, and higher-speed short-reach data links connecting computing devices are increasingly required. Such links commonly use a combination of vertical-cavity surface-emitting lasers (VCSELs) and silica-glass-based multimode optical fibers (MMFs). However, further boosting per-lane data rates toward the 212.5-Gbps class is challenging because transmission bandwidth is constrained by modal dispersion and material dispersion in the optical fiber. In this work, the researchers demonstrated a GI POF that provides transmission bandwidth exceeding that of silica MMF by precisely controlling the refractive-index profile to reduce modal dispersion and by using a perfluorinated polymer with lower material dispersion than silica glass.

These results were accepted and presented at the Optical Fiber Communication Conference (OFC) 2026, one of the world's largest international conferences in optical communications, as a co-authored paper by KPRI of Keio University and Broadcom Inc.

1. Research Background

In AI data centers, vast amounts of data must be exchanged rapidly and in parallel among large numbers of computing devices. As a result, the performance of the data links connecting them—primarily short-reach links spanning from a few meters to several tens of meters within and between racks—has a major impact on the overall computing capability of the data center. For such short-reach links, the combination of vertical-cavity surface-emitting lasers (VCSELs) and silica-glass-based multimode optical fibers (MMFs) is widely used. To meet growing demand for data transmission, efforts are underway worldwide to increase per-lane data rates from the current 106.25-Gbps class to the next-generation 212.5-Gbps class.

However, one of the major challenges in further increasing data rates is the limitation imposed by the transmission bandwidth of the optical fiber. The transmission bandwidth of MMF is mainly limited by modal dispersion and material dispersion. Modal dispersion is a phenomenon in which differences in arrival time arise because light propagates along different paths for different modes; this can be suppressed by appropriately designing the refractive-index profile of the fiber core (the path through which light travels). In contrast, material dispersion is a phenomenon in which differences in arrival time arise among wavelengths because of the wavelength-dependent refractive index of the optical fiber material itself. In particular, VCSELs typically emit light containing multiple wavelength components, resulting in a broad spectral width*1 and making the impact of material dispersion more significant.

2. Research Results

The Keio Photonics Research Institute (KPRI) at Keio University has been conducting research and development on graded-index plastic optical fiber (GI POF) for high-speed data transmission.

In this study, the researchers successfully developed a GI POF that provides transmission bandwidth exceeding that of silica MMF by precisely controlling the refractive-index profile to reduce modal dispersion and by using a perfluorinated polymer with lower material dispersion than silica glass. The GI POF also exhibits low-noise characteristics for high-quality data transmission, as previously proposed by KPRI. These characteristics originate from the material's microscopic heterogeneous structure.

Figure 1 (left) shows the wavelength dependence of material dispersion. Around 850 nanometers, the standard operating wavelength of VCSELs, the perfluorinated polymer exhibits material dispersion that is smaller (close to zero) than that of silica glass. Figure 1 (right) shows the theoretically predicted transmission bandwidth, indicating that the perfluorinated GI POF can achieve approximately 1.6 times the bandwidth of silica MMF by appropriately controlling the GI profile exponent g[*2] (assuming a center wavelength of 850 nanometers and a spectral width of 0.60 nanometers).

Figure 2 shows experimentally verified transmission bandwidth based on frequency-response[*3] measurements. In silica MMF (OM5, a high-performance category, was used in the experiment), the response at higher frequencies decreased as the spectral width of the VCSEL increased, and both the −1.5 dBo bandwidth ($f_{-1.5\,\mathrm{dBo}}$) and the −3.0 dBo bandwidth ($f_{-3.0\,\mathrm{dBo}}$) decreased. In contrast, the GI POF maintained better frequency responses and achieved transmission bandwidths exceeding those of silica MMF.

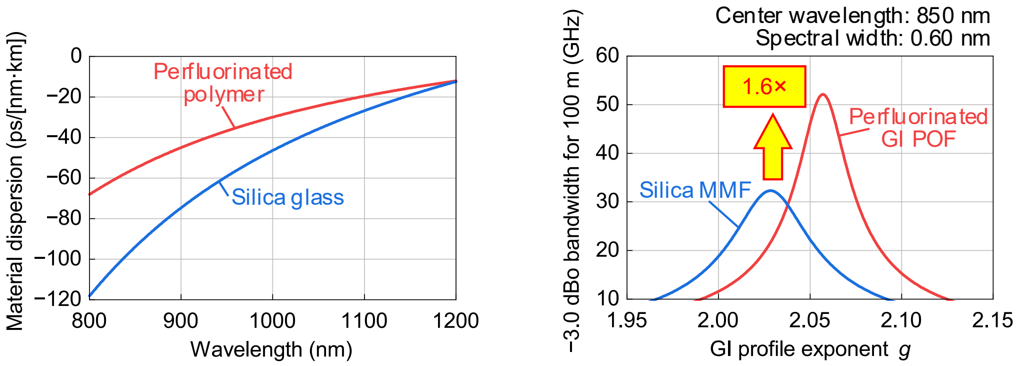


Figure 1. (Left) Comparison of material dispersion between perfluorinated polymer and silica glass. (Right) Comparison of theoretical transmission bandwidth.

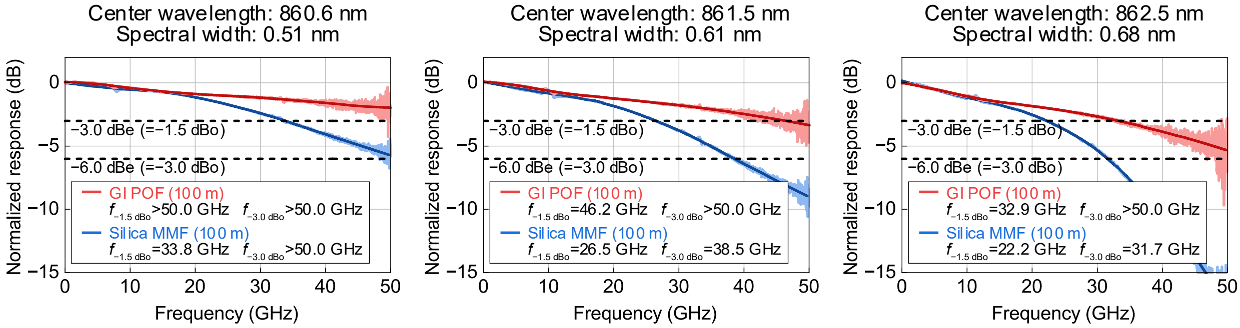
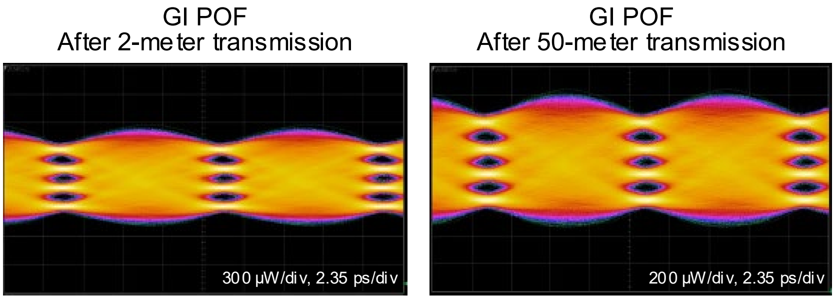


Figure 2. Experimental results for transmission bandwidth. (Left), (center), and (right) show the frequency responses of the optical fibers measured under different VCSEL spectral widths.

By combining the GI POF developed at KPRI with a next-generation high-speed VCSEL developed by Broadcom Inc., single-lane transmission at 212.5 Gbps over 50 meters was successfully demonstrated using a 106.25-Gbaud PAM4*4 signal. As shown in Figure 3, even after 50-meter transmission, a good-quality signal waveform (a well-opened eye diagram*5) was obtained, showing minimal degradation relative to the reference waveform after 2-meter transmission. These results demonstrate that the GI POF is capable of delivering high transmission performance for next-generation 212.5-Gbps-class short-reach links, highlighting its potential to enable higher-speed optical interconnects in data centers.



Data rate	: 212.5 Gb/s
Modulation	: PAM4
Symbol rate	: 106.25 Gbaud
Pattern	: PRBS15Q
Extinction ratio	: 2.4 dB
Center wavelength	: 861 nm
Spectral width	: 0.45 nm

Figure 3. Transmission waveforms of a 212.5-Gbps signal over GI POF. (Left) Waveform after 2-meter transmission. (Center) Waveform after 50-meter transmission. (Right) Experimental conditions.

3. Research Paper

Conference	:	Optical Fiber Communication Conference (OFC) 2026
Paper title	:	200G/lane 50-m Multimode VCSEL Link by Low-Material-Dispersion Graded-Index Plastic Optical Fiber
Authors	:	Kenta Muramoto[1], Hongdi Mou[2], Yasuhiro Koike[1]
Affiliations	:	1. Keio Photonics Research Institute (KPRI), Keio University 2. Broadcom Inc., Optical Systems Division
Paper Number	:	Th1A.2

4. Glossary

*1 Spectral width

A measure of the spread of light wavelengths. In VCSELs, the RMS value, defined as the standard deviation of the emission spectrum, is generally used as the spectral width. IEEE 802.3 standards specify a VCSEL spectral width of 0.60 nanometers or less for use with silica MMF, taking into account the impact of material dispersion.

*2 GI profile exponent *g*

An index representing the shape of the refractive-index profile in the core of an optical fiber. In GI fibers, the refractive index changes continuously from the center of the core toward the radial direction, and this profile can be represented by the exponent *g*. By appropriately controlling *g*, modal dispersion can be minimized and transmission bandwidth can be maximized.

*3 Frequency response

The relationship between signal frequency and the corresponding response (attenuation) at that frequency. Bandwidth is defined as the frequency at which the frequency response decreases to a specified level relative to 0 hertz. In optical fibers, the −1.5 dBo bandwidth ($f_{-1.5\ \mathrm{dBo}}$) and the −3.0

dBo bandwidth ($f_{-3.0\ \mathrm{dBo}}$) are widely used as performance metrics. Higher bandwidth values indicate the ability to transmit higher-frequency signals and therefore better suitability for high-speed data transmission.

*4 PAM4

An abbreviation for 4-level pulse-amplitude modulation, one of the modulation formats widely used in high-speed data transmission. Whereas conventional binary modulation transmits data using two amplitude levels, "0" and "1," PAM4 uses four amplitude levels, enabling the transmission of 2 bits per symbol, such as "00," "01," "10," and "11."

*5 Eye diagram

A method for visually evaluating signal quality by superimposing signal waveforms. The larger the eye opening formed by the overlapping waveforms, the less the influence of noise and distortion, indicating better signal quality.

5. Acknowledgments

These research results were obtained from the commissioned research (JPJ012368C08001) by National Institute of Information and Communications Technology (NICT), Japan.

*Please direct any requests or inquiries to the contacts listed below in advance of any press coverage.

*We have sent this news release to the MEXT Press Club, Science Press Club, and the city news and cultural divisions of other media outlets.

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