

Furukawa Electric Develops New Pump Source Technology for Raman Amplification

OFC 2019, Booth 2639, San Diego, California, March 6, 2019 – Furukawa Electric has developed new Pump Source technology for Raman amplification using incoherent light. The new Pump Source technology using incoherent light suppresses the effect of fluctuations in the pump light on the signal light. This makes it possible to realize co-propagating Raman amplification, the practical application of which has been difficult in the past. Co-propagating Raman amplification is an effective technology for the improvement of transmission characteristics and extension of transmission distance in optical fiber communications. This new development is expected to contribute greatly to the development of high-speed and large-capacity optical fiber communications systems, including for digital coherent optical transmission at 600 Gb/s and at over 1 Tb/s, which is being developed around the world in response to the expected rapid increase in traffic in the 5G era.

This new Pump Source technology and its effectiveness in Raman amplified light transmission were presented at Photonics West 2019 and is being showcased at OFC 2019 in San Diego, California, March 5 - 7, 2019.

Background

Together with Er-doped optical fiber amplification (EDFA), Raman amplification is one of the core technologies currently supporting optical fiber communications. The first practical application of EDFA was in the early 1990s. It uses 1.48 μm and 0.98 μm pump lasers. Furukawa Electric has led the world in the development of higher output 1.48 μm pump lasers and their practical application. The development of a high-power 1.48 μm pump laser promoted the development of Raman amplification technology and the practical application of the technology was achieved from the late 1990s to the early 2000s. In Raman amplification, the signal is amplified in a distributed fashion along the cabled transmission fiber, providing two benefits that cannot be achieved using other methods: signal transmission is more linear and has fewer impairments because the power is more uniform along the fiber link, and less noise is added to the signal

compared to use of EDFA-only amplification. These benefits greatly improve transmission performance by overcoming fiber attenuation without degrading the signal.

However, in Raman amplification, fluctuations in pump power can be transferred to the amplified optical signal. This effect is maximum when the pump travels in the same direction as the signal (co-propagating) and minimum when the pump travels in the opposite direction (counter-propagating). Therefore counter-propagating Raman amplification, where the amplification is from the receiving side, is used as the standard method. In counter-propagating Raman amplification, the fluctuation of the pump light impressed on the signal light is averaged and the effect of it is reduced. However, there is a limit to the improvement of the transmission characteristics of the signal that has already propagated through the optical fiber. Co-propagating Raman amplification makes it possible to maximize the effect of Raman amplification, which further improves transmission characteristics. For this reason, it has long been hoped that new Pump Source technology would be developed to improve noise performance for co-propagating Raman amplification.

Details

This new Pump Source technology from Furukawa Electric uses Amplified Spontaneous Emission (ASE) emitted by a Semiconductor Optical Amplifier (SOA) as an incoherent light source. ASE is random light that does not have the fluctuations between oscillating modes that are seen in lasers with Fabry-Perot resonator structures. Even in co-propagating Raman amplification, it has no effect on the signal light.

However, optical modules for application to optical fiber communications systems must have a small size and high reliability. Furukawa Electric has SOA and advanced packaging technology that has been cultivated in the development of signal light Source for digital coherent optical transmission. By fully utilizing these technologies, we have now succeeded in the development of compact and high-output, incoherent light source technology. Because an ASE source is broadband in nature, it can be used for either first-order or second-order Raman pumping for long or high loss spans, to reduce the cost-per-bit of transport.

Furukawa Electric has continued to lead the world in the field of pump lasers for Raman amplification and EDFA. With this new development of Pump Source technology using incoherent

light, we will continue to contribute to the development of optical fiber communications systems with larger capacities and greater sophistication.

Related Research Presentations

[1] M. Morimoto et al “Co-Propagating Distributed Raman Amplifier Utilizing Incoherent Pumping” *Photonics West 2019*, Invited Paper 10946-21

[2] T. Kobayashi et al, “PDM-16QAM WDM Transmission with 2nd-order Forward-pumped Distributed Raman Amplification Using Incoherent Pumping” *the Optical Fiber Communication Conference (OFC) 2019*, paper Tu3F.6

About Furukawa Electric Company, Ltd.

Furukawa Electric Co. Ltd. (www.furukawa.co.jp/english) is an \$11 billion global leader in the design, manufacture and supply of fiber optic products, network products, electronics components, power cables, nonferrous metals, and other advanced technology products. Headquartered in Tokyo, Japan, Furukawa operates production facilities on five continents around the globe, including OFS in the USA, Europe and China.

About OFS

OFS is a world-leading designer, manufacturer and provider of optical fiber, fiber optic cable, connectivity, fiber-to-the-subscriber (FTTx) and specialty fiber optic products. We put our development and manufacturing resources to work creating solutions for applications in such areas as telecommunications, medicine, industrial automation, sensing, aerospace, defense and energy. We provide reliable, cost-effective fiber optic solutions that help our customers meet the needs of consumers and businesses today and into the future.

Headquartered in Norcross (near Atlanta) Georgia, U.S.A., OFS is a global provider with facilities in China, Denmark, Germany, Morocco, Russia and the United States. OFS is part of Furukawa Electric Company, a multi-billion-dollar leader in optical communications.

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