Tellurite-Based Fiber Raman Amplifiers

Wavelength-division multiplexing (WDM) transmission systems with huge number of signal channels have been recognized as the best way to construct large capacity optical networks. However, the available channels in WDM transmission systems have been limited by the gain bandwidth of optical amplifiers. Wide-band optical fiber amplifiers are therefore indispensable key devices for future optical networks. To date, two types of wide-band amplifiers have been reported. The first is a parallel-type amplifier multiplexing the gain bands, namely, the S\textsuperscript{1} (1460-1530 nm)-band TDFA\textsuperscript{2} and the C\textsuperscript{3} (1530-1565 nm)-band and L\textsuperscript{4} (1565-1625 nm)-band EDFAs\textsuperscript{5}. The other is a silica-based fiber Raman amplifier featuring a multi-wavelength pump technique. The parallel-type amplifier has achieved a gain bandwidth of more than 100 nm, but noise characteristics deteriorate due to excess loss of the de-multiplexing filter at the input section. For the fiber Raman amplifier, it is difficult to realize a discrete-type amplifier with a gain bandwidth of more than 100 nm because the Stokes shift of silica-based glass is about 100 nm for 1550-nm amplification.

NTT Laboratories have developed a new ultra-wide-band tellurite-based fiber Raman amplifier to amplify optical signals from the S to L bands simultaneously. Tellurite-based glasses have a higher Raman gain coefficient and a larger Stokes shift than silica glass. These features allow us to realize highly efficient wide-band amplifiers. In fact, the amplifier achieves a gain bandwidth of 160 nm (S+C+L band) with a gain of more than 10 dB for a 4-wavelength LD\textsuperscript{7} pump scheme. The transmission characteristics of such 160-nm amplifiers have been evaluated in the WDM transmission system. Our preliminary results confirm that the amplifier can be used as a booster, in-line, or pre-amplifier without serious problem.

In future research, we plan to optimize the tellurite-based fiber structure for achieving lower loss and flattening gain spectrum. We will also study signal transmission characteristics in detail.

(Photonics Laboratories)

Modulation of Perceived Contrast by a Moving Surround

The coming broadband era brings with it a growing demand for efficient methods of transferring high volumes of data, such as for video images. We are conducting research to clarify unique human characteristics and are using these characteristics to create new technologies that are suited to broadband environments.

We gain awareness of our world through our eyes, ears, and other sensory organs. These perceptions, however, do not necessarily correspond with the physical world. The human brain processes input information, and what we perceive is nothing more than the result of this processing. A familiar example is what we call "visual illusions". In the upper figure, we have two small circles with the same contrast. If we surround a circle with a high-contrast background (as with the left circle), the circle appears more blurred. This is because our brain calculates the contrast of the central segment based on that of the surroundings. This illusion reduces the perceived contrast.

We found that if we move the surroundings, the perceived contrast of the central circle increases. This is due to the response characteristics of the brain’s mechanism for detecting visual motion. The estimated increase in the perceived contrast in the central segment due to moving the surroundings is 50 %. We also tested this phenomenon using a video of a running animal (lower pictures). The surround was moved rightward while the camera captured the animal’s image at the center. When the surround was stationary, both the animal and surround images were perceived as blurred. However, once the surround began to move, the animal was clearly perceived, even when the blurred images accounted for more than 70 % of all the images. The animal image is similar to compressing the image information. Through applications of this human mechanism, we can compress videos into smaller capacity units more efficiently than with existing methods.

(Communication Science Laboratories)

Contrast modulation due to surround

When the surround is stationary, the center contrast is reduced.
When the surround is moved, the perceived contrast of the center increases.