NTT
NIPPON TELEGRAPH AND TELEPHONE CORPORATION

NEWS RELEASE

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New breed of optical fiber, "Holey Fiber", shows prospects for application

Research advancing rapidly on application of new holey fiber allowing ultra large capacity optical communication and cost reduction

Nippon Telegraph and Telephone Corporation (NTT -- Chiyoda-ku, Tokyo, President: Norio Wada) has made giant leaps in research into the application of a new optical fiber that possesses optical properties unattainable with conventional fiber. The fiber is attracting attention as the next generation of transmission medium and photonic device.

The new optical fiber is called "Holey fiber" (*1). While conventional optical fiber is composed of a core surrounded by a cladding, the core of holey fiber contains air holes arranged like a crystal lattice (Figure). Through design of the size, number, separation, and arrangement of the holes, holey fiber has achieved many optical characteristics impossible with conventional fiber such as single-mode in an extremely wide range of wavelengths, a dramatic reduction in bending loss, and high polarization maintenance. The pronounced reduction in bending loss has made holey fiber markedly easier to handle, unlike its conventional counterpart, which does not transmit light through when bent. This means that no special cable-laying procedure is required and that laying and installation is more flexible.

Now that the broadband era is well and truly upon us, and at a time of rapid growth in fiber optic services exemplified by B FLETS, holey fiber, the result of pioneering research and development by NTT, is expected to contribute to the provision of a fast, low-cost fiber optic service to customers.

Background

Optical fiber is widely used as an integral component in the infrastructure supporting a continually growing IT community, and its scope of application is broadening to include not only backbone network but also access networks. However, on account of the optical characteristics of conventional optical fiber, in which dopants are used to form a waveguide in silica glass, the limits of increase in optical transmissions capacity at current wavelength range. Bending loss, connection loss, and other problems, which contribute to optical fiber's status as hard-to-handle at the time of laying, are also issues.

In aiming to create a more economical network by extensively boosting backbone capacity, NTT has conducted research and development of holey fiber, which has excellent transmission and bending loss characteristics -- this research has produced many pioneering results. **One example is the steady loss reductions that have been achieved with photonic crystal optical fiber, which contains dozens of holes.** In

March 2003, NTT Access Network Service Systems Laboratories set a world record for low loss levels (0.37 dB/km) and six months later in September broke its own record and set another one (0.28 dB/km). In pushing the boundaries of intrinsic loss in silica fiber (minimum limit 0.14 dB/km), NTT is conducting research and development aimed at the introduction of holey fiber in the future.

Hole-assisted optical fiber, which has several holes, not only reduces bending loss but reveals the fundamental structure required to achieve connection loss levels comparable to those of conventional fiber technology.

Characteristics of new-generation optical fiber

Of the various types of holey fiber, the photonic crystal fiber, with which NTT recently set the world record for low loss levels, has the following main characteristics.

- single-mode (*2) over a very wide range of wavelengths
- major reduction in bending loss (can be effectively zero)
- a variety of dispersion properties (*3)
- flexible control of light non-linearity (*4)
- high polarization-maintenance (*5)

The expansion in the range of single-mode wavelengths has generated great expectations for an increased range of wavelengths available for WDM (*7) in the photonic networks of the future (*6), which will enable greatly increased capacity in optical communication. This suggests ultra-high capacity optical communication using wavelengths ranging from the visible to the near infra-red in the future.

The emergence of hole-assisted optical fiber has opened the way to optical fiber that has low losses when bent, and this has increased the possibility of putting in place a high-speed communication infrastructure quickly and at low cost.

Future developments

NTT will continue to conduct research into the feasibility of photonic crystal optical fiber as a future transmission medium in the form of discovering transmission characteristics at wide wavelengths and investigating how the performance of such transmission can be improved, as well as establishing testing, connection, and cabling technologies. We are also continuing to investigate alternative structures for bend-resistant optical fiber and will continue research and development with the aim of applying this technology as soon as possible.

Terms

***1 Holey fiber**
A collective term for optical fiber containing air holes. Representative examples include hole-assisted fiber (highly refractive core and a few holes), photonic crystal fiber (silica glass core and several dozen holes), and photonic band-gap fiber (hollow core and dozens of holes).

***2 Single-mode**
A collective term for guiding one transmitted mode. A single-mode optical fiber is

more suitable for high speed transmission than multimode fibers.

***3 Dispersion**
A phenomenon that optical pulses with different wavelengths move at different velocities.

***4 Non-linearity**
A dependence of refractive index on the optical power in the fiber.

***5 Polarization-maintenance**
A collective term for maintaining a constant state of polarization along the fiber.

***6 Photonic network**
A collective term for next-generation optical networks suited to high-capacity communication. Optical components are used and high speed is achieved by communicating using only light signals, without any conversion to electronic signals.

***7 WDM**
Wavelength-division multiplexing. A technique in which several optical signals of differing wavelengths are transmitted down the same optical fiber. WDM is attracting attention as a key technology for achieving a photonic network. There has also been much research into dense WDM (DWDM) in recent years.

- Figure
  Holey fiber cross-section

Please direct any enquiries on this media release to
CHIZUKA, SANO, or IDA
Public relations, Planning division
NTT Information Sharing Laboratory Group
Phone: 0422-59-3663
E-mail: koho@mail.rdc.ntt.co.jp