High-performance backup power system and Energy density advantage of nickel-metal hydride batteries

Traditionally, NTT has installed lead-acid batteries in strategic locations as an emergency backup power source to ensure that communications services can be kept up and running even in the event of a disaster or other power failure. But with the enormous increases in power consumed by telecom equipment in recent years to support faster and more advanced communications services, it has become increasingly difficult to provide the same duration of backup time as in the past using lead-acid batteries. This is because lead-acid batteries are so heavy and bulky that it is becoming harder to house the battery capacity needed to support modern equipment requirements. Also, lead-acid batteries deployed in outdoor plant facilities tend to degrade in hot environments during summertime, and this increases the cost of maintaining and replacing lead-acid batteries. These disadvantages highlighted the need to develop a new type of battery-based backup power system that is smaller, lighter weight, and has a longer life expectancy than lead-acid batteries.

Having settled on the nickel-metal hydride (NiMH) battery as the best alternative to lead-acid batteries in terms of energy density, NTT Laboratories have improved the characteristics of NiMH cells for power backup. A range of peripheral equipment-including a high-efficiency and reliable charger, discharger, and system controller—has also been developed to derive the maximum performance of NiMH batteries.

These efforts culminated in the development of a backup power system for base transceiver stations with 10 kWh capacity (provides 3 hours of backup at DC 48 V and load current of 60 A). Compared to previous battery backup power systems, the weight and volume of the batteries have been dramatically reduced by close to 50%. NiMH cells also hold up much better in high-temperature environments. They last up to eight years in an ambient temperature of 45°C, which is nearly double that of lead-acid batteries. Finally, NiMH batteries provide an environmentally friendly backup power solution, because they do not contain lead which is identified as a toxic substance.

Future work will concentrate on further increasing the capacity of backup power systems, and on developing larger UPS* systems and dual-use systems that employ batteries both for backup and peak offset to even out the power usage of communications buildings and data centers.

* UPS: Uninterruptible Power Supply

Development of Photonic Crystal Fiber

NTT Laboratories are researching and developing "photonic networks" to enhance the capabilities of broadband communication. Photonic networks use optical technology to implement signal processing at higher layers to provide signal multiplexing/demultiplexing and switching and routing functions, in addition to high-speed optical transmission. To this end, system components that make up the network must exhibit high levels of performance and new functions. Photonic crystal fiber (PCF) exhibits characteristics not possible with traditional fiber: (1) it can be designed to offer single mode operation at any wavelength, (2) it allows a great degree of freedom in designing the zero-dispersion wavelength, and (3) it enables large non-linear and birefringence characteristics to be achieved. PCF is expected to enhance the functions of various types of components used in the photonic network.

At NTT Laboratories, we have developed PCF with characteristics superior to existing polarization-maintaining optical fiber as well as providing low loss. As shown in the figure, PCF consists of a quartz core surrounded by a lattice array of air holes. In conventional optical fibers, dopants are added to the core section to increase the refractive index, but in PCFs, the average refractive index of the air-hole-array section is less than that of the core section even without dopants. This means that light is confined to the core section, due to its higher refractive index, which gives rise to optical fiber transmission. By selecting the appropriate combination of air-hole diameters and intervals, PCF can offer new functions that are not possible with conventional optical fiber. As shown in the cross-section photograph, setting different diameters for holes near the core on the two main axes alters the refractive index encountered by polarized waves in those directions resulting in good polarization maintenance (birefringence). Good polarization maintenance means that polarized light within the fiber is stable, which in turn means that optical components that use such fiber can operate stably and perform extremely efficient optical-signal processing as high-performance system components. At NTT Laboratories, we have succeeded in developing low-loss PCF that offers excellent polarization-maintaining characteristics by placing air holes with different diameters near the core. As shown in the figure, its PCF polarization-maintaining performance is about three times that of existing polarization-maintaining fiber.

Our future research will discover even more novel functions in PCF with the aim of developing various types of high-function system components and contributing to the advancement of photonic networks in the broadband era.

Schematic structure of PCF

Cross section of polarization maintaining (PM) PCF and birefringence characteristics