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Research on Optical Communication Devices in Japan

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Optical fiber transmissions are extensively studied under various subject categories, such as optical components, fibers and systems, aiming at wide applications, including public telecommunication services in Nippon Telegraph and Telephone Public Corporation.(1) (2)

It is anticipated that medium capacity optical PCM systems will be developed first. Research on associated optical components, fibers and cables is in progress. Silica-based multimode fibers are mainly studied for these application. Fiber production techniques with as low loss as 3 dB/km at the 0.85 μm band have been established in many research organizations by a chemical vapor deposition method. Plastic clad fibers have been confirmed to have 3.7 dB/km loss at 0.85 μm and 2.4 dB/km at 1.05 μm.(3) Research is now directed toward economic fiber mass production and cabling. AlGaAs light emitting diodes with separate emitting and guiding layers have been developed. Fiber coupling was improved by attatching a miniaturized lens to the output surface. Reliability is confirmed to exceed 10^4 hours.(4) Fiber coupling efficiency of 6-8 % has been reported by using a small emitting area LED and a spherically shaped fiber end.(5) Silicon avalanche photodiodes have been developed for the 0.85 μm band. In reach-through type APD, 65 % quantum efficiency, 6 dB excess noise at a multiplication factor of 100 and 0.1 nA dark current have been achieved at 100 V operating voltage.(6)

Semiconductor lasers are studied for high speed applications at 100-800 Mbit/s.(7) Longitudinal or transverse mode control of semiconductor lasers has been successful, with distributed feedback(8) or buried heterostructure(9) lasers. Reliability of AlGaAs semiconductor lasers is still a severe problem and many research workers are involved in the improvement study. By selecting good quality substrates, long lived devices, more than 10^3 hours, are available with sufficient yield. In order to realize a reliability of more than 10^5 hours, required by a transmission system design, elucidation of long term degradation mechanism and further refinement in crystal growth and fabrication techniques will be necessary.

It is expected that the silica-based fiber loss will be reduced beyond 1 μm. Aiming at the 1.05 μm wavelength oscillator, miniaturized solid state lasers are studied. By using a high quality $LiNdP_4O_{12}$ crystal, a compact CW laser was demonstrated by a semiconductor laser pump.(10) Waveguide type optical modulators are being researched for low voltage modulation in high digit rate applications by using $LiNbO_3$ or $LiTaO_3$ crystals.(11) (12) (13)

Recently, extremely low loss fibers were fabricated with 0.47 dB/km loss at the 1.2 μm wavelength by reducing OH content.(14) By using such extremely low loss fibers, repeater spacing will be extended up to 30-50 km, and system economy and reliability will be significantly improved.(15) Power supply and repeater maintenance problems will be relaxed. Optical devices in the low loss wavelength region, such as oscillators(16) (17) and detectors,(18) are yet to be developed.

Applications to supervision and control systems in electrical power networks and to CATV are regarded as hopeful. Experiments in field environments have already started.

In order to develop economic optical fiber transmission systems, fiber joining techniques, connectors and components for optical integrated circuits are extensively studied.

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