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Preface

Fiber optic advances made in the 1980s have revolutionized the concept of telecommunications services and applications. With the development of integrated photonics and a timely deployment, the prospects of lightwave systems are expected to be brighter in future.

To assure low maintenance, long lifetime systems, reliable fiber optics are being developed at a considerable effort. It is true that worldwide use of fiber optics in both terrestrial and undersea cable communication links has made even the skeptics to believe in the high reliability of lightwave systems. However, concern for reliability still remains in yet unexplored areas such as application of photonics in space or other harsh environments. Also, developing high reliability components and fail-safe systems design at a *competitive* cost remains a challenge.

Many international conferences were held annually since 1985 by SPIE to address the reliability issues in fiber optics. Both benign and adverse environmental effects are considered in these conferences and performance evaluated for their influence on component selection and overall systems reliability and maintenance strategy. A large body of field experience data, failure statistics, test procedures as well as reliable components and systems from vendors are now available to fiber optic designers. However, as the present systems and applications mature and new directions evolve, it is appropriate to revisit the reliability issues and critically review the current status and projections for future development.

A critical reviews of fiber optic reliability and test methods was organized for the SPIE "Optical Tools for Manufacturing and Advanced Automation - the University-Industrial Partnership at Work" '93 meeting in Boston. A selected group of experts, each recognized for contribution in fiber optics reliability, presented extended invited papers on specified topics which included both components and systems (e.g., optical fiber and cable, light emitter and transmitter, photodetector and receiver, optical connector and splice, integrated optics and OEICs). Effect of operating conditions, both benign and adverse, was addressed. Also, critical issues in fail-safe system design, failure allocation and reliability specification, and cost-performance trade-off were discussed.

In this Conference, altogether thirteen papers were presented in four half-day sessions dedicated to address *fiber optic reliability, passive optical components, active optical components, and systems,* respectively. These critical review sessions were alternated with the sessions of the regular annual SPIE conference, *Fiber Optics Reliability and Testing: Benign and Adverse Environments -- Sixth in a Series,* held simultaneously in Boston. A strong participation of telecommunications industries and several national and international government laboratories and agencies produced a successful conference.

A detailed discussion of optical fiber reliability models and mechanical strength testing procedures shed light on modeling of fiber fatigue and measurement and analysis of the lifetest data. The papers by H. Yuce, Bellcore, and M. Matthewson, Rutgers University, stimulated many questions and comments. Development of optical fiber coatings to prevent hydrogen diffusion at high temperature, reliability of splices and connectors and lifetime measurement and estimation methods were critiqued in several papers. D. Biswas, Fiberguide Industries, traced the development of optical fiber coatings, such as polymeric, metallic, and inorganic materials, routinely applied on commercial telecommunications fibers. P. Lemaire, Bellcore, addressed hydrogen diffusion induced attenuation in silica fibers. B. Lefevre, AT&T Bell Labs., reviewed the common failure modes in optical connectors and splices and prescribed methods to produce high performance passive optical components. An interesting paper by G. Kiss, Bellcore, provided a case history of the *self-healing failures* of cables in outside aerial plants. Such field failures, typically observed during cold spells, are characterized by a loss increase in the cable at 1550 nm wavelength and very often occur within a distance too close to the splices to be resolved by standard OTDR testing. Sheath shrinkage and differential thermal expansion and contraction of the cable structure causing "creeping" of the central dielectric member and attendant bending of the excess length with a high microbending loss are the major factors in this type of field failure.

The state-of-the-art performance and long-term reliability of long wavelength diode lasers and photodetectors were reviewed by N Dutta, AT&T Bell labs. In another paper, R. Craig from Spectra Diode Inc., reviewed the status of much higher power semiconductor lasers operating at ~ 1 μm wavelength. Effect of space radiation (equivalent total dose and dose rate) on fiber optic cables, optoelectronic devices, and integrated optical components was discussed in two papers by B. Evans, Boeing Aerospace and P. Marshall, NRL. Reliability of $LiNbO_3$ integrated optical devices was reviewed by P. Suchoski, United Technologies Photonics. D. Paul of COMSAT Laboratories presented the design of a high reliability fail-safe optical communications network in the last session on systems and network reliability. The trade-off between component reliability, cost, and redundancy requirements was established by two case examples, an undersea fiber cable link with optoelectronic regenerators and a free-space lasercom link interconnecting two communications satellites.

The depth and coverage of the topics presented led to continued discussion of the concerns and collaborative investigations of reliable fiber optics. In this context, SPIE has once again taken the lead to provide a very useful technical forum to critique and document the state-of-the-art reviews and future trends of high-reliability fiber optic components and systems. The proceedings of these critical reviews promises to be a significant reference work for the fiber optic professionals and libraries.

Finally, I would like to thank the authors/speakers, SPIE organizers, and the audience for making the conference successful. Specially acknowledged are Ms. Anne Noteboom, SPIE Technical Program Coordinator, and Ms. Aleta Springer, Proceedings Coordinator, of the Boston Symposia for their patience in scheduling the sessions with last minute corrections and for gently nudging the authors for the manuscripts to expedite publication of the proceedings.

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