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Book Review

Reliability of Photonics Materials and Structures (Proceedings of the Reliability of Photonics Materials and Structures Symposium held April 13–16, 1998 in San Francisco, CA). Ephraim Suhir, Mitsuo Fukuda, and Charles R. Kurkjian, editors, published by Materials Research Society, Warrendale, PA, 1998. 420 pages. MRS Member Price: $69.00; U. S. List Price: $79.00; Non-US Price: $91.00.

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This book contains proceedings from the Materials Research Society symposium Reliability of Photonics Materials and Structures that was held April 13-16, 1998 in San Francisco, CA as part of the Materials Research Society Spring Meeting. Accordingly, this review will include comments on the symposium based upon the content of the papers presented in this book. The book is divided into seven parts dealing with (1) review presentations, (2) materials reliability, (3) strength degradation, fatigue, and aging, (4) structural analysis and modeling, (5) high-strength and metallized fibers, (6) performance in harsh environments, and (7) photonic devices and reliability of optical performance. In the interest of time, comments are provided on selected papers from each part. Therefore, these comments should not be considered representative of every paper in the book.

Part I features four very good overviews, two of which are commented upon here. In the paper "Dense-WDM Components and Systems: A Reliability Overview," Shahab Etemad reviews field failure data relating to materials and devices essential to optically amplified dense-wavelength division multiplexed (DWDM) transmission systems. DWDM provides an attractive alternative to use of new fiber for networks by capitalizing on optical multiplexing and demultiplexing schemes such that signals are transported over several hundred miles without having to convert to the electrical domain. In the paper "Critical Issues in the Mechanical Reliability of Lightguide Fibers," C. R. Kurkjian discusses the effects of flaws and coating chemistries on the prediction of fiber lifetimes. A relation is presented to show the strength degradation as a time-varying stress is applied to a fiber flaw. The influence of water and humidity affect the strength characteristics. Some data is presented relating crack velocity to stress intensity factor under varying conditions of humidity.

In Part II, eleven papers are presented on Material Reliability. T. Svensson presents a paper that discusses the B-parameter, a property that facilitates fatigue resistance determination. The B-value is one of two fatigue parameters used to evaluate fiber strength. However, uncertainties in evaluating B resulted in its demise and, consequently, the practice of substituting statistical parameters, acquired from proof test data, was instituted as a preferred approach. Yet, this approach was questioned as providing excessively conservative results and the use of "B" was resurrected. Svensson presents data from tensile and bend tests and includes information on acrylate-coated silica fibers. In a paper by Jin and Mavoori, data is presented on creep resistant solders with emphasis on use in photonic equipment. The paper discusses the effects of fine oxide dispersed additives and their subsequent improvement of creep resistance in eutectic tin-lead solder. With these dispersoids, eutectic solder provides an attractive option for opto-electronic package assembly. The remainder of Part II is strong in providing mechanical, reliability, and material property data on other photonic materials.

Part III addresses strength degradation, fatigue, and aging. In one article, M. J. Matthewson discusses fatigue and strength behavior of fused silica optical fibers by studying the combined effects of stress, temperature, and corroding species (e.g., humidity, pH, etc.). An emphasis on kinetics is provided in understanding how stress affects the rate of strength degradation. Similarly, a paper by N. Evanno, M. Poulain, and A. Gouronnec, discusses effects of water and pH on fiber strength. Therefore, Part III also stands out as a strong point of this book by providing very good data in the design of photonic equipment in harsh environments.

Part IV includes articles on structural analysis and modeling. E. Suhir provides three papers that discuss various effects of optical-fiber bending stresses. This information would be beneficial to designers as the ever-expanding role of photonics technology forces the use of fibers in high stress modes common to traditionally used copper conductor wire. Another paper, by J. M. Anderson et. al., studies the cause of optical fiber breaks in the ferrule at the entry cone/alignment capillary transducer region. This information could benefit field personnel involved in failure analysis and subsequent repair.

The topic area of Part V is high strength and metallized fibers. Included is a paper by A. S. Biriukov et al. on temperature effects on the performance of optical fibers with copper coating. Other papers discuss Ni-P, tin, and nickel coatings as well as application techniques such as freezing and effects of coatings on fiber strength enhancement.

Part VI deals with fiber performance in harsh environments. Three papers comprise this portion of the book. (These papers discuss reliability aspects: it is unclear why these were not included in Part III.) Specific issues addressed include wavelength photodiode performance in humid ambients, fiber sensors on a cable bridge, and performance of fiber optics in low temperature environments.

Part VII addresses photonic devices and the reliability of optical performance. In one paper, Sidorov and others discuss degradation effects in light emitting diodes (LEDs) based on GaAs(Si). The paper reports on experiments to study internal mechanical stresses (from semiconductor fabrication defects) and their degradational effects on LEDs.

In general, this book serves as a useful archive of information in photonics and opto-electronics. Photonics is rapidly making progress as an alternative to electronics in many applications such as communications and control. The information, presented in this book, addresses the needs of the mechanical engineer in resolving various issues regarding reliability, fatigue, and overall strength. All of these are essential components in guaranteeing optimal performance of fiber-optic and photonic equipment.

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