

# Contents

- ix *Conference Committee*  
xi *Preface*

## FREE-SPACE OPTOELECTRONIC INTERCONNECTS

- 3 **Vertical-cavity surface-emitting lasers for free-space interconnects**  
L. A. Coldren, B. J. Thibeault, Univ. of California/Santa Barbara
- 35 **Low-power approaches for parallel free-space photonic interconnects**  
R. F. Carson, M. L. Lovejoy, K. L. Lear, M. E. Warren, P. K. Seigal, D. C. Craft,  
S. P. Kilcoyne, G. A. Patrizi, O. Blum, Sandia National Labs.
- 64 **Board-to-board free-space optical interconnects of bus architecture**  
J. Ma, V. H. Ozguz, S. H. Lee, Univ. of California/San Diego
- 68 **Smart multichip module communications using free-space optical interconnects**  
D. S. McCallum, P. S. Guilfoyle, OptiComp Corp.
- 88 **Multilevel phase holograms for free-space optical interconnects: design and analysis**  
A. F. Gmitro, C. L. Coleman, Optical Sciences Ctr./Univ. of Arizona
- 106 **Integrated optoelectronic interconnects using liquid-crystal-on-silicon VLSI**  
J.-J. P. Drolet, G. Barbastathis, D. Psaltis, California Institute of Technology

## INTERCONNECT ARCHITECTURES

- 135 **VCSEL array-based optoelectronic crossbar interconnect**  
Y. Li, T. Wang, R. A. Linke, NEC Research Institute
- 156 **Optoelectronic parallel computing system with reconfigurable optical interconnection**  
M. Ishikawa, Univ. of Tokyo (Japan)
- 176 **Network-related performance issues and techniques for MPPs**  
S. L. Johnsson, Univ. of Houston and Harvard Univ.
- 210 **Bit-parallel wavelength links for high-performance computer networks**  
L. A. Bergman, Jet Propulsion Lab.; A. J. Mendez, Mendez R&D Associates;  
L. S. Lome, Ballistic Missile Defense Organization

## HIGH-SPEED TRANSCEIVERS FOR OPTOELECTRONIC INTERCONNECTS

- 229 **VCSEL-based optical interconnections at interbox distances and shorter**  
J. L. Jewell, Picolight Inc.
- 244 **Design and fabrication of low-power 1-Gb/s OEIC receivers**  
W. Chang, D. D. Airola, M. Feng, Univ. of Illinois/Urbana-Champaign
- 267 **Clock recovery for high-speed optical communication**  
K. D. Pedrotti, Rockwell International Corp.

## BACKPLANE OPTOELECTRONIC INTERCONNECTS

- 299 **Performance-optimized optical bidirectional backplane bus for multiprocessor systems**  
R. T. Chen, C. Zhao, T. Oh, Univ. of Texas/Austin
- 318 **Intracomputer optical interconnects: progress and challenges**  
J. P. Bristow, Honeywell Technology Ctr.

## INTRA- AND INTER-MCM OPTOELECTRONIC INTERCONNECTS

- 329 **Optical interconnection using polyimide waveguide for multichip module**  
M. Koyanagi, Tohoku Univ. (Japan)
- 343 **Implementation of optical interconnects in the GigaRing supercomputer channel**  
R. W. Wickman, Cray Research Inc.
- 366 **Optoelectronic interconnects for three-dimensional wafer stacks**  
D. E. Ludwig, J. C. Carson, Irvine Sensors Corp.; L. S. Lome, Ballistic Missile Defense Organization

## OPTOELECTRONIC PACKAGING

- 393 **POLO: a gigabyte/s parallel optical link**  
K. H. Hahn, D. W. Dolfi, Hewlett-Packard Labs.
- 405 **Polymer optical interconnect technology (POINT): optoelectronic packaging and interconnect for board and backplane applications**  
Y. S. Liu, R. J. Wojnarowski, W. A. Hennessy, GE Corporate Research and Development Ctr.; J. P. Bristow, Y. Liu, A. Peczalski, Honeywell Technology Ctr.; J. R. Rowlette, A. Plotts, J. D. Stack, AMP, Inc.; J. T. Yardley, L. Eldada, AlliedSignal Inc.; R. M. Osgood, R. Scarmozzino, Columbia Univ.; S. H. Lee, V. H. Ozguz, Univ. of California/San Diego

- 415 **Fabrication and performance of optical interconnect analog phase holograms made by electron-beam lithography**  
P. D. Maker, D. W. Wilson, R. E. Muller, Jet Propulsion Lab.
- 431 **Packaging and applications of active polymer optical switching arrays**  
R. S. Lytel, F. Lipscomb, Akzo Nobel Electronic Products Inc.
- 442 **Potential of LIGA technology for optoelectronic interconnects**  
W. Bacher, P. Bley, H. O. Moser, Forschungszentrum Karlsruhe GmbH (FRG)



# Conference Committee

## *Conference Chairs*

**Ray T. Chen**, University of Texas/Austin  
**Peter S. Guilfoyle**, OptiComp Corporation

## *Session Chairs*

- 1 Free-Space Optoelectronic Interconnects  
**Peter S. Guilfoyle**, OptiComp Corporation
- 2 Interconnect Architectures  
**Julian P. Bristow**, Honeywell Inc.
- 3 High-Speed Transceivers for Optoelectronic Interconnects  
**Yao Li**, NEC Research Institute
- 4 Backplane Optoelectronic Interconnects  
**Randy W. Wickman**, Cray Research Inc.
- 5 Intra- and Inter-MCM Optoelectronic Interconnects  
**Yung S. Liu**, GE Corporate Research and Development Center
- 6 Optoelectronic Packaging  
**Ray T. Chen**, University of Texas/Austin



## Preface

Optoelectronic interconnects and packaging are becoming increasingly important due to the requirement of high-speed, large-capacity transmission of information. Such a demand in many scenarios such as machine-to-machine and module-to-module interconnects can only be realized by employing optoelectronic technology.

In this critical review, we have invited 26 internationally known experts in this field to address such critical technical issues as vertical cavity surface emitting lasers, photodetectors, holograms and smart pixel arrays for both guided wave and free-space optoelectronic interconnects. Architecture-related subjects are also delineated to provide a global picture of future development. Several system demonstrations, including 500-MHz optical clock signal distribution for Cray Research's T-90 machine, ARPA-sponsored POINT and POLO programs, and the most recent developments on optoelectronic packaging are also detailed in this book.

We expect the engineers, scientists, and students in this field to find this book useful for their research.

**Ray T. Chen**  
**Peter S. Guilfoyle**