Emerging Semiconductor Technology

Gupta/Langer
editors

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Foreword

The Fourth International Symposium on Semiconductor Processing was held at San Jose, California on 28-31 January, 1986 under the chairmanship of Dinesh C. Gupta, Siliconix Incorporated. The Symposium was sponsored by ASTM Committee F-1 on Electronics and co-sponsored by National Bureau of Standards, Semiconductor Equipment and Materials Institute, Stanford University Center for Integrated Systems, and IEEE Components, Hybrids and Manufacturing Technology Society. The Technical Committee was headed by Paul H. Langer, AT&T Bell Laboratories and the Arrangements and Publicity Committee was headed by Carl A. Germano, Motorola Incorporated.

The Symposium was successful because of the efforts of many persons who participated in the Advisory Board, and various committees, namely, the Technical Committee, the Arrangements and Publicity Committee, Registration Committee and the Spouse Committee. These persons included: Winthrop A. Baylies, ADE Corporation, Kenneth E. Benson, AT&T Bell Laboratories, W. Murray Bullis, Siltec Corporation, Paul Davis, Semiconductor Equipment and Materials Institute, James R. Ehrstein, National Bureau of Standards, Bruce L. Gehman, Deposition Technology Incorporated, Kathleen Greene, ASTM, Gilbert A. Gruber, Siliconix Incorporated, Lou Ann Gruber, Vijay Gupta, John A.Imbalzano, E.I. DuPont DeNemours & Company, Sharon Kaufmann and Philip L. Lively, ASTM, George E. Moore, Sr., Semiconductor Equipment and Materials Institute, James D. Plummer, Stanford University Center for Integrated Systems, Robert I. Scace, National Bureau of Standards, William R. Schevey, Allied Chemical Corp., Donald G. Schimmel, AT&T Bell Laboratories, Robert B. Swaroop, Fairchild Semiconductor, Gail Wesling, and Paul Wesling, Tandem Computers Incorporated.

In addition, the guidance was provided by the Chairman and the officers of ASTM Committee F-1 on Electronics, its various subcommittees including the Executive subcommittee. The following persons presided the technical and workshop sessions: J. Albers and A. Baghdadi, National Bureau of Standards, K. E. Benson, AT&T Bell Laboratories, J.O.Borland, Applied Materials, Inc., R.H.Bruce, Xerox Palo Alto Research Center, M. Buehler, Jet Propulsion Laboratory, W. M. Bullis, Siltec Corporation, S. Cox, AT&T Technologies, M. Current, Applied Materials, Inc., J. R. Ehrstein, National Bureau of Standards, B. Fay, Micronix Corporation, T. Francis, Air Products & Chemicals, G. A. Gruber and D. C. Gupta,

Siliconix, Inc., T. I. Kamins, Hewlett-Packard Laboratories, G. Koch, Flexible Manufacturing Systems, P. H. Langer, AT&T Bell Laboratories, J. Matlock, SEH America, R. K. Pancholy, Gould AMI Semiconductor, M. Pawlik, GEC Research, D. Perloff, Prometrix, Inc., J. Plummer, Stanford University Center for Integrated Systems, D. Walters, Varian Associates, Inc., W. R. Schevey, Allied Chemical Corporation, L. Shive, Monsanto Company, E. R. Sirkin, Zoran Corporation, F. Voltmer, Intel Corp., and W. Weisenberger, Ion Implant Services.

We are indebted to Richard D. Skinner, President, Integrated Circuit Engineering Corporation who presented a dinner speech on "Semiconductor Industry - An Economic Review", Richard A. Blanchard, Vice President, Siliconix Incorporated, Pat Hill Hubbard, Vice President, American Electronics Association, Richard Reis, Assistant Director, Stanford University Center for Integrated Systems, Robert I. Scace, Deputy Director, Center for Electronics and Electrical Engineering, National Bureau of Standards, James E. Springgate, President, Monsanto Electronic Materials Company, and James A. Thomas, Vice President, ASTM for the keynote speeches on the various topics on the first day of the Symposium.

We are grateful to the members and guests of ASTM Committee F-1 and Standards Committees of SEMI who were called upon from time to time for special assignments during the two-year planning of the Symposium.

Over one hundred and fifty scientists participated all over the world in the review process for the papers published in this publication. Without their participation, this publication would not have been possible.

And finally, we acknowledge the hard work and efforts of the staff of publication, review, editorial and marketing departments of ASTM in bringing out this book.

A Note of Appreciation to Reviewers

The quality of the papers that appear in this publication reflects not only the obvious efforts of the authors but also the unheralded, though essential, work of the reviewers. On behalf of ASTM we acknowledge with appreciation their dedication to high professional standards and their sacrifice of time and effort.

ASTM Committee on Publications

Related ASTM Publications

Semiconductor Processing, STP 850 (1984), 04-850000-46

Silicon Processing, STP 804 (1983), 04-804000-46

Lifetime Factors in Silicon, STP 712 (1980), 04-712000-46

Laser-Induced Damage in Optical Materials: 1982, STP 847 (1984), 04-847000-46

Laser-Induced Damage in Optical Materials: 1981, STP 799 (1983), 04-799000-46

Laser-Induced Damage in Optical Materials: 1983, STP 911 (1985), 04-911000-46

Preface

The papers in this volume were presented at the Fourth International Symposium on Semiconductor Processing held in San Jose, California on 28-31 January, 1986. The Symposium was sponsored by ASTM Committee F-1 on Electronics, and co-sponsored by National Bureau of Standards, Semiconductor Equipment and Materials Institute, Stanford University Center for Integrated Systems, and IEEE Components, Hybrids and Manufacturing Technology Society. In addition to the technical presentations, the symposium included two well-attended workshops, impressions of which are provided in appendix I.

The symposium addressed new problems in semiconductor technology and day-to-day problems in semiconductor processing for the mid 80's which arise from the rapid increases in device complexity and performance, emergence of integrated systems on-a-chip, automated factories, and silicon foundries. In the face of these demands, the realization of acceptable yields and reliability requires greater manufacturing and process-control disciplines from starting materials to finished devices. The symposium theme was, again this year, chosen to be Quality Through Measurement and Control.

The symposium opened with the talks on Standards and Product Quality by James A. Thomas, ASTM, and Standards for the Semiconductor Industry from ASTM and SEMI by Robert I. Scace, National Bureau of Standards. These presentations were followed by two papers giving the overview of silicon technology and relating it to device requirements. The requirements of silicon materials were described by James E. Springgate, Monsanto Electronic Materials Company. The process and equipment considerations were discussed by Richard A. Blanchard, Siliconix Incorporated.

The opening general session included a presentation and a discussion on Graduate Education for the Electronics Industry. Pat Hill Hubbard, Vice President, American Electronics Association discussed various programs that the Foundation is involved in in order to make doctoral study and academic careers more attractive. She said, "The need to have an adequate supply of quality engineers and sufficient faculty to educate them is considered of paramount importance to the health of the high tech industry and to the economic health of the nation." Richard Reis, Assistant Director, Stanford University Center for Integrated Systems presented a graduate education mix from Stanford's point

of view, noting the exceptions which make Stanford different from other schools in the nation.

The response to the symposium was extremely favorable once again. The involvement of industry, academia and government including the participation of foreign institutions confirmed a continued need for a regular forum to discuss technology topics in the context of measurement and control, a consistent theme which the Symposium established in 1982 involving the understanding and day-to-day control of the complex process technologies required for VLSI and other advanced device concepts.

The plans for the next symposium in 1988 in the series of symposia to be held at two-year intervals are underway. The problem areas and standardization needs identified in these symposia will provide the feedback to the research community and voluntary standards system essential for the future growth of the industry.

The cooperation and support of the ASTM staff in the formulation of this publication is appreciated. We are indebted to our industrial, government and university colleagues who contributed to the Symposium and the Proceedings.

Dinesh C. Gupta
San Jose, California.

Paul H. Langer
Allentown, Pennsylvania.

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