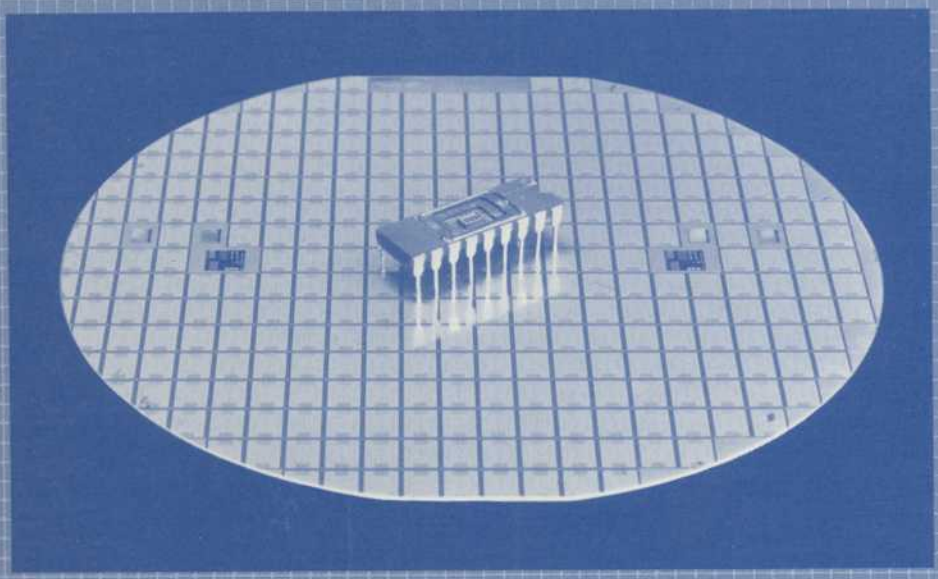
Semiconductor Processing



D. C. Gupta, editor

ASTM STP 850

SEMICONDUCTOR PROCESSING

A symposium
sponsored by ASTM
Committee F-1 on Electronics,
National Bureau of Standards,
Semiconductor Equipment and Materials Institute,
and Stanford University IC Laboratory
San Jose, CA, 7-10 Feb. 1984

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Foreword

The Third Symposium on Semiconductor Processing was held at San Jose, California on 7-10 February, 1984 under the chairmanship of Dinesh C. Gupta, Siliconix Incorporated. It was sponsored by ASTM Committee F-1 on Electronics and co-sponsored by the National Bureau of Standards, Semiconductor Equipment and Materials Institute and Stanford University Integrated Circuits Laboratory. The Technical Committee was headed by Edward E. Gardner, IBM Corporation and the Arrangements and Publicity Committee by Carl A. Germano, Motorola Incorporated.

The following persons participated in the Advisory Board, and various Committees, namely; the Technical Committee, the Arrangements and Publicity Committee, Registration Committee and the Spouse Committee: Lisa Anderson, SEMI; Kenneth E. Benson, AT&T Bell Laboratories; W.Murray Bullis, Siltec Corporation; Kathleen Bullis; Michael H. Christ, Dynamit Nobel Silicon; Peter Douglas, American Fine Wire Corporation; Terry A. Francis, Air Products Corporation; Barbara Germano; Gilbert A. Gruber, Siliconix, Inc., Lou Ann Gruber; Vijay Gupta; Heinz Herzer, Wacker-Chemitronic, Philip L. Lively, ASTM; Robert D. Larrabee, National Bureau of Standards; Robert E. Lorenzini, Siltec Corporation; Samuel L. Marshall, Solid State Technology; Jan Meighan, San Jose Convention Bureau; James D. Meindl, Stanford University; Eric Mendel, IBM Corpoation; J. Timothy Raab, Rockwell International; Robert I. Scace, National Bureau of Standards; Donald G. Schimmel, AT&T Bell Laboratories; Fritz G. Vieweg-Gutberlet, Wacker-Chemitronic and William R. Wheeler, Tencor Instruments.

In addition, the guidance was provided by the Chairmen and the officers of ASTM Committee F-1 on Electronics and its various subcommittees. The following persons presided the technical and workshop sessions: K.G.Barraclough, Royal Signals & Radar Establishment; K.E.Benson, AT&T Bell Laboratories; W.M.Bullis, Siltec Corporation; P.L.Castro, Hewlett-Packard Laboratories; M.I.Current, Trilogy Systems Corporation; P. Douglas, American Fine Wire Corporation; C. A. Germano, Motorola, Inc., G.G.Harman, National Bureau of Standards; H. Herzer, Wacker-Chemitronic; P. H. Langer, AT&T Bell Laboratories; R. D. Larrabee, National Bureau of Standards; B. J. Masters, IBM Corporation; J.H.Matlock, SEH America Inc., A. R. Neureuther, University of California, Berkeley; A. Rapa, IBM Corporation; W. R. Schevey, Allied Chemical

Corporation; G.R.Srinivasan, IBM Corporation; B.Stone, Monsanto Company & C.J.Varker, Motorola Incorporated.

We are specially indebted to William Cavanaugh, President of ASTM, for an impressive talk on "The Role of ASTM in the Electronics Industry", Sheldon Weinig, Chairman, Materials Research Corporation and a member of the President's Advisory Council on Private Sector Initiatives who presented a dinner speech on "Competitive IC Market: Will Automation and Technology Improvements Offset the Rising Costs of Manufacturing and Equipment", and to the members of the panel on Cooperative Research; Erich Bloch, Chairman, Semiconductor Research Cooperative and Director, National Science Foundation; Richard Fair, Vice President, Microelectronics Center of North Carolina; Angel Jordan, Provost, Carnegie-Mellon University; James Meindl, Director, Stanford Center for Integrated Systems; and William Oldham, Professor, University of California, Berkeley. The panel was moderated by Dr. Angel G. Jordan.

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

Over one hundred and forty persons participated in the review process for the papers published in these proceedings. 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 and editorial 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

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

Preface

The papers in this volume were presented at the Third Symposium on Semiconductor Processing held in San Jose, California on 7-10 February 1984. The symposium was sponsored by ASTM Committee F-1 on Electronics, and co-sonsored by National Bureau of Standards, Semiconductor Equipment & Materials Institute and Stanford University Integrated Circuits Laboratory. In addition to the technical presentations, the symposium included well-attended workshops and panel discussions; impressions of these workshops and panel discussions are provided in appendices I-III.

The symposium addressed new problems in semiconductor technology 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. The realization of acceptable yields and reliability in the face of these demands requires greater manufacturing discipline from starting materials to finished devices. The symposium theme was chosen to be Quality Through Measurement and Control.

The symposium opened with the talks on the role of ASTM in the electronics industry by William T. Cavanaugh, ASTM, and the impact of standards on semiconductor quality and manufacturing efficiency by W. Murray Bullis, Siltec Corporation. These presentations were followed by two keynote papers, one on the process and device modeling for VLSI structures by James D.Plummer, Stanford University and the other on the equipment requirements for the VLSI production by Wilmer R. Bottoms, Varian Associates. Both these papers described techniques and equipments needed to achieve the required functional yields in complex devices on an integrated circuit chip.

The opening general session included a discussion on the Cooperative Research among industry, academia and government. Brief summaries of activities at the Semiconductor Research Cooperative, Microelectronics Center of North Carolina, Stanford Center for Integrated Systems and the University of California at Berkeley were presented. A synopsis of the panel discussion in response to key questions from the audience is presented in appendix I.

Many other forums including the Fifth International Conference on Neutron Transmutation Doping and the

CHMT chapter of IEEE decided to meet with the Symposium.

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 evolving the understanding and control of the complex process technologies required for VLSI and other advanced device concepts.

The plans for the next symposium in 1986 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 these proceedings is appreciated. Finally, we are indebted to our industrial, government and university colleagues who contributed to the contents of the Symposium and the Proceedings.

San Jose, California. Dinesh C. Gupta

Contents

CONTROL OF PARTICULATE CONTAMINATION

DEFECTS AND GETTERING TECHNIQUES

NEUTRON TRANSMUTATION DOPING TECHNIQUES AND FACILITIES

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