Foreword

RECENT ADVANCES in GaAs semiconductor material growth, the development of e-beam for submicron lithography, and improved processing techniques have not only improved the performance of conventional field-effect transistors but also resulted in several novel heterostructure devices. At the present time, the focus of the activity in materials is on producing highly uniform and consistent epitaxial layers and improving processing techniques to produce submicron geometries.

With improved materials technology, the band structures in GaAs devices can be engineered by introducing materials with different band gaps in different regions of the device. This flexibility provided by materials technology has resulted in several novel HEMT structures, among them pseudomorphic and lattice matched (InP-based) structures. Both structures are now being actively pursued. Their noise performance at both ambient and cryogenic temperatures has set new records. They are now being extensively used in applications requiring low-noise performance. InGaAs-based HEMT's also exhibit potential as power devices.

Heterojunction bipolar transistors (HBT's) are fast emerging as an alternative to silicon bipolar and FET at microwave frequencies. This is attributed to their low power consumption, high power density, wide dynamic range, low harmonic distortion, and low phase noise. For applications such as EW, radar, and smart weapons, their radiation hardness and high yield could be effectively used to achieve low-cost systems. Several HBT-based MMIC circuits have already been reported for both digital and analog applications.

MESFET, the workhorse of the three-terminal devices, has continued to improve over the years. The performance of these devices has improved considerably and with shorter gate length they are now usable at millimeter-wave frequencies.

All these device developments have encouraged and stimulated researchers in areas such as large-signal characterization, accurate high-frequency parasitic modeling, and noise characterization. This, in turn, has enabled circuit designers to realize maximum potential of newer three-terminal solid-state devices.

It can be observed that all three technologies, i.e., MESFET's, HEMT's, and HBT's, will continue to be successful in their own way and will have their own niche applications while providing the best performing components for microwave and millimeter-wave systems.

In view of these developments and to assess future trends, the Microwave Theory and Techniques Society's Technical Committee on Microwave and Millimeter-Wave Solid-State Devices (MTT-7) sponsored a workshop on "FET Structures and Their Modeling." This workshop was held in conjunction with the 1988 International Microwave Symposium in New York.

The workshop program included presentations by eight speakers, who provided in-depth reviews of the technical advances made so far and focused on the problems and bottleneck issues of this technology. They also provided a forum for discussions on future directions. The workshop was very well attended and there was considerable audience participation. It is my pleasure to thank those active participants of the workshop who shared their experiences and concerns with the rest of us and endeavored to make this technical exchange very informative.

In keeping with the overwhelming interest of the workshop participants, it was thought that a Special Issue of the MTT TRANSACTIONS would be timely. The Technical Committee on Microwave and Millimeter-Wave Solid-State Devices has sponsored this Special Issue. The objective is to present the background information, current state of the art, and future trends in new FET structures and their modeling aspects. The speakers at the workshop were invited to contribute along with open solicitation for this Special Issue. The response to the call for papers was very encouraging, as evidenced by the number of papers appearing in this issue. This Special Issue is organized in four major sections. The three invited papers present an overview of the state of the art in HEMT, HBT, and MISFET technologies. The next four papers are on power devices and amplifiers. Various modeling aspects of devices are dealt with in nine papers. The next seven papers describe the new and novel structures. In addition, there are six short papers briefly touching on modeling aspects and applications.

As Guest Editor, I have enjoyed working to bring about this issue. I would like to express my appreciation to the large number of authors and reviewers whose efforts have made this publication possible. The names of the reviewers are as follows:

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JITENDRA GOEL
Guest Editor

Jitendra Goel (S'70–M'76–SM'83) received the B.S. degree in physics from Agra University, India, in 1961 and the B.S.E.E. degree, with specialization in communications, from the University of Roorkee, India, in 1964. He obtained the M.S.E.E. degree from the University of Lowell, Lowell, MA, in 1971. He then did his Ph.D. work at Rutgers University in New Jersey.

From 1964 to 1965, he was with Murphy India, Ltd., as a design engineer involved in the design of radio frequency receivers. From 1965 to 1969 he was with the Brown Boveri Corporation as a design group leader, where his responsibilities included the development of RF circuits used for the protection of power generation and distribution networks. In 1971, he joined Tucker Electronics as a chief engineer, primarily involved with the design of instrumentation test sets. From 1973 to 1979 he was with the Microwave Technology Center of RCA Laboratories, David Sarnoff Research Center, Princeton, NJ, as a member of technical staff. There his responsibilities included the design and fabrication of GaAs power devices. He worked on various circuits including dual-gate FET mixers, phase shifters, discriminators, oscillators, and power amplifiers. In 1979 he joined the Electronic Systems Group of TRW, Redondo Beach, CA, as a senior staff engineer, primarily responsible for space-qualified solid-state power amplifiers for TWTA replacement. He also managed the Advanced Microwave Technology Department. Since 1986, he has been involved in the technical management of GaAs-related research activities. He has published more than 35 technical papers in the area of microwave and millimeter-wave devices and circuits and is the holder of 16 U.S. patents.

Mr. Goel is active in the IEEE Microwave Theory and Techniques Society. Presently he is cochairman of the High Power Microwave Subcommittee. He has been a member of the editorial board of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES and of the Technical Program Committee of the IEEE MTT-S International Microwave Symposium since 1985. He is also on the editorial board of *Microwave and Optical Technology Letters*, a journal published by John Wiley, and on the power panel of the NPB committee of SDI.