Foreword

THIS SPECIAL issue on GaAs Integrated Circuits covers a selection of the best papers presented at the 1981 IEEE GaAs Integrated Circuits Symposium held in San Diego, CA. While the realization of integrated circuits using GaAs is fairly recent, the first experimental work on GaAs and other III–V compound semiconductors began in 1951. In the late 1950's, a number of researchers independently proposed p-n junction semiconductor lasers with GaAs being the prime materials candidate. Extensive developmental efforts on improved GaAs materials began in a wide variety of research laboratories including those in Europe, Great Britain, and the United States. The discovery of the Gunn effect in 1964 further stimulated the need for the high quality GaAs material and improved processing device techniques. However, it was Carver Mead's proposal of the Schottky barrier gate field effect transistor in 1966 that really provided the impetus for the material and device research. This conceptually simple device, when coupled with semi-insulating GaAs substrates and the growing research on ion implantation, led to declarations that GaAs would be the semiconductor of the future. At that time, the commercial applications of GaAs microwave devices were restricted to a limited market for discrete devices such as Gunn diodes and point contact and Schottky barrier detector and mixer diodes. Thus, in the 1960's the GaAs technology did not achieve the commercial importance silicon had. On the other hand, researchers in the Department of Defense recognized the potential for GaAs devices and circuits to meet special DOD needs for lower noise, higher frequency of operation, higher speed signal processing, higher power, and higher efficiency. The implementation of many of these devices and circuits on a single semi-insulating substrate was even possible. In the late 1960's and early 1970's industrial programs covering a wide spectrum of GaAs technology development were funded by DOD including substantial efforts in bulk and epitaxial materials, ion implantation, and a wide range of devices. In May of 1977 the Defense Advanced Research Projects Agency funded the first effort specifically directed toward developing a high speed, low power, digital IC technology utilizing Schottky barrier FET's and selective ion implantation into semi-insulating substrates. From the mid-70's to the present, the GaAs technology base has broadened to include low noise amplifiers, power amplifiers, digital circuits, and CCD's. These developments now include a wide range of device complexity from discrete FET's to linear integrated circuits to LSI level digital circuits with technological capabilities in laboratories encompassing all of the major industrial nations of the world.

In 1979 Dr. D. H. Phillips organized the first IEEE Gallium Arsenide Integrated Circuits Symposium under the sponsorship of the Electron Devices Society. This specialty conference has provided a forum for reports on digital and linear integrated circuits on GaAs as well as covering the material, processing, and device advances which support the integrated circuits. The 1979 Symposium at Lake Tahoe was an instant success, attracting 340 attendees. The total attendance has risen about 10 percent per year to 423 in 1981. The 1981 conference attracted papers from England, France, Italy, Japan, and the U.S. In fact, nearly one-third of the papers presented in 1981 were from overseas organizations.

In recognition of the importance of the work on GaAs integrated circuits, this issue of the IEEE TRANSACTIONS ON ELECTRON DEVICES is devoted to full-length papers based on work presented at the 1981 GaAs IC Symposium. The technical program committee of the GaAs IC Symposium met at the conclusion of the technical sessions and selected the top papers for inclusion in this issue. The lead-off paper by Van Tuyl *et al.*, which details a common process technology for both digital and analog GaAs IC's, was the only unanimous choice. In addition, three papers have been included in this issue which were not presented at the conference but represent related regular papers in the ED-S TRANSACTIONS.

This issue is divided into three categories for both the convenience of the reader and topical consistency. The first five papers deal with materials and processes used to realize integrated circuits with GaAs. The first paper describes a complete approach to both analog and digital circuit fabrication at Hewlett Packard. The next two discuss LEC GaAs growth properties while the last two cover problems with backgating and how to avoid or minimize them.

The second section consists of three papers on analog IC's. Two papers cover ultra-broad-band distributed amplifiers with over 10 : 1 bandwidths. The third shows a working monolithic phase shifter using dual gate FET's as gain control elements.

The last section covers the digital circuits. The first of five papers outlines the work underway in Japan to create an LSI or VLSI technology for GaAs IC's. The remaining four detail a variety of digital circuits ranging from a word generator to a static RAM cell.

We would like to thank the many reviewers who contributed to the timely appearance of this issue and to the members of the Technical Program Committee of the 1981 GaAs IC Symposium who planned the conference, chose the papers presented from a large group of submissions, and finally elected the best for inclusion in this issue.

JOHN E. DAVEY
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Guest Editors

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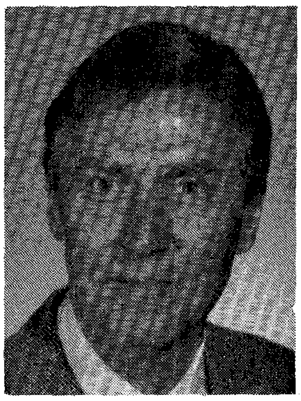
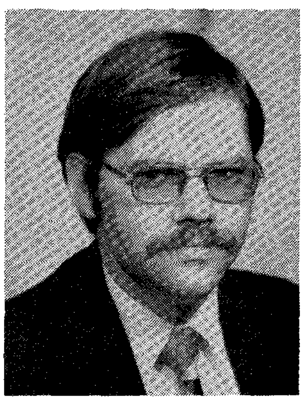


John E. Davey (SM'64) received the B.S. degree in physics from Canisius College, Buffalo, NY, in 1949, and the M.S. and Ph.D. degrees in physics from the University of Notre Dame, Notre Dame, IN, in 1951 and 1954, respectively.

From 1954 to 1958 he was employed as a Research Physicist at the Naval Research Laboratory, Washington, DC, carrying out fundamental studies of thermionic and photoemission from compound semiconductor surfaces. From 1958 to 1968 he was Head of the Functional Devices Section of the Solid State Electronics Branch being engaged in basic and applied research on elemental and compound semiconductor thin-film materials and devices. During this period, among other research investigations, he carried out the first studies of vacuum epitaxial deposition of semiconducting films, publishing work on vacuum homoepitaxy of germanium in 1962 and the first work on the vacuum epitaxy of GaAs in 1967. In 1969 he became Head of the Solid State Devices Branch at the Naval Research Laboratory directing research programs on microwave devices, ion implantation, MIS devices, elemental and compound semiconductor device, and circuit processing and device reliability. He received the Navy Meritorious Civilian Service Award in 1979.

Dr. Davey is a member of the American Physical Society, the American Vacuum Society, and Sigma Xi.



James G. Oakes (SM'73–M'75) received the B.S. (1969), M.S. (1972), and Ph.D. (1974) degrees in electrical engineering from Cornell University, Ithaca, NY.

He joined the Solid State Division of the Westinghouse Research and Development Laboratories in 1974. From 1974 to 1976 his research focused on a vertical silicon MOS transistor designed for high pulsed output powers at 1 to 2 GHz. Since 1976 he has worked on GaAs FET's investigating low-noise FET oscillator characteristics, power FET characterization and modeling, and digital circuits. He is currently the Manager of the Microwave Devices group which is developing broad-band GaAs power monolithic circuits using direct ion implantation.

Dr. Oakes serves on the Microwave Devices Technical Committee of the IEEE Electron Devices Society. He has served as Symposium Chairman (1981) and Technical Program Chairman for the 1980 IEEE GaAs IC Symposium in Las Vegas, NV.