## PREFACE

This volume is the continuation of our recently published book on silicon carbide materials and devices.

As we stated in our Preface to Volume I, silicon carbide has been known investigated since 1907 when Captain H. J. Round demonstrated yellow and blue emission by applying bias between a metal needle and a SiC crystal. In 1923, a Russian scientist, Oleg Losev, discovered two types of light emission from SiC – the emission that we would now call "pre-breakdown" light and the electroluminescent emission. The potential of using SiC in semiconductor electronics was already recognized about a half of century ago. The most remarkable SiC properties are:

- Wide band gap (3 to 3.3 eV for different polytypes
- Very large avalanche breakdown field (2.5 – 5 MV/cm)
- High thermal conductivity (3 – 4.9 W/cm K)
- High maximum operating temperature (up to 1,000 °C)
- Chemical inertness and radiation hardness

However, some of these potential advantages also cause exceptional technological difficulties in getting silicon carbide material to reach the device quality, and it has taken a few decades to travel the road from basic research to commercialization.

The breakthrough was reached in early 1990s, when nearly all basic semiconductor devices – p-n diodes, Schottky diodes, Metal Oxide Semiconductor Field Effect Transistor (MOSFETs), Metal Semiconductor Field Effect Transistor (MESFETs), bipolar junction transistors, thyristors, IMPATT diodes, and solar blind photodetectors – have been successfully demonstrated.

The first commercial SiC devices – power switching Schottky diodes and high temperature MESFETs – are now on the market.

For nitride based devices, silicon carbide has become a substrate of choice, because of its excellent thermal conductivity and decent lattice match. This includes both electronic and blue light emitting diodes and lasers, and, together with nitride based semiconductors, silicon carbide is now in the forefront of the semiconductor research.

The contributors to this two-volume book are recognized leaders in SiC technology and materials and device research. They provide complete and up-to-date review of the state-of-the-art.

The first volume has chapters on SiC materials properties (Chapter 1), SiC homo- and hetero-epitaxy (Chapter 2), Ohmic and Schottky contacts to SiC (Chapters 3 and 4), High

Power p-i-n rectifiers (Ch. 5), Microwave SiC diodes (Ch. 6), Thyristors (Ch. 7), and SiC static induction transistors (Ch. 8).

This second volume has additional four chapters. Chapter 1 on the growth of SiC substrates is authored by CREE, Inc. scientists who represent the company that has been a pioneer, innovator, and research and market leader in SiC technology. Chapter 2 (authored by Dr. Lebedev from famous A.F. Ioffe Institute) deals with deep defects in different SiC polytypes.

Deep defects define the properties of bulk SiC and, in many ways, the performance and reliability of SiC devices. In Chapter 3, Drs. Stephani and Friedrichs review recent work on SiC JFETs. Since demonstration of SiC JFETs by ONR-University of Minnesota-CREE, Inc. team[1] in 1980's, SiC JFETs demonstrated advantages related to bulk electron mobility in the channel (as opposed to much lower field effect mobility in SiC MOSFETs) and higher temperature performance. The last chapter by T. Paul Chow (Rensselaer Polytechnic Institute) and Anant K. Agarwal (CREE, Inc.) deals with Bipolar Junction Transistors (BJTs). This chapter reviews the complicated device physics raising many interesting and controversial issues important for these devices, which are still to demonstrate their full potential.

Both volumes will be useful for technologists, scientists, engineers, and graduate students who are working on silicon carbide or other wide band gap materials and devices. These books can also be used as a supplementary textbook for graduate courses on silicon carbide and wide band gap semiconductor technology.

[1] G. Kelner, M. S. Shur, S. Binari, K. Sleger, and H. S. Kong, High-Transconductance β-SiC Buried-Gate JFET's, IEEE Trans. Electron Devices, ED-36, No. 6, pp. 1045-1049 (1989); G. Kelner, M. S. Shur, S. Binari, K. Sleger, and H. S. Kong, A High Transconductance β-SiC Buried-Gate Junction Field Effect Transistor, in Proceedings of 2nd International Conference on Amorphous and Crystalline Silicon Carbide and Related Materials (ICACSC'88), Santa Clara, pp. 184-190, December (1988)