Preface

Silicon carbide (SiC) has emerged as a cornerstone material for next-generation power electronics, offering unprecedented opportunities to improve the efficiency, power density, and reliability of electrical energy conversion systems. Advanced electrical characteristics, superior thermal conductivity, and chemical and mechanical stability enable SiC semiconductor devices to operate at high voltages, elevated temperatures, and high switching frequencies. These attributes have positioned SiC at the forefront of technological developments in electric transportation, renewable energy systems, industrial automation, and aerospace applications.

The presented special edition considers the principles, methodologies, and innovative approaches that underpin the practice of developing advanced SiC-based power semiconductor structures. The edition explores concepts for a broad spectrum of devices based on SiC MOSFETs, including, for example, bidirectional power switches and Gate Turn-Off (GTO) thyristors.

Particular attention is given to the relationship between device architecture and electrical performance. Topics such as P-well doping, P-well boosting, edge termination, and Junction Termination Extension (JTE) are examined as essential design strategies for controlling the electric-field distribution, minimising leakage, and maximising breakdown voltage. Capacitance–voltage measurements and other characterisation techniques are discussed as powerful tools for evaluating doping profiles, interface quality, and charge distribution, while Technology Computer-Aided Design (TCAD) is presented as an indispensable framework for simulation, optimisation, and predictive device engineering.

The special edition also analyses on-state characteristics, switching behaviour, and high-frequency operation, emphasising the importance of balancing conduction efficiency with dynamic performance. This book provides a comprehensive perspective on the practice of designing SiC power devices and the strategies required to achieve superior performance and long-term reliability.

Intended for researchers, device engineers, and graduate students, this special edition offers both fundamental insights and practical guidance for the design of advanced power semiconductor devices. We hope that the contributions presented herein will stimulate further innovation and support the continued expansion of SiC power electronics into increasingly important industrial and societal applications.