Preface

Silicon carbide (SiC) has transformed the field of power electronics by enabling semiconductor devices that can operate at higher voltages, temperatures, and switching frequencies than silicon-based devices. As SiC technologies mature, a detailed understanding of device performance, reliability, and failure mechanisms has become essential for advancing research and its industrial implementation.

This special edition is devoted to investigations into the characterisation and interpretation of the electrical and thermal behaviour of modern SiC power devices. Particular emphasis is placed on SiC MOSFETs, Schottky diodes, and Junction Barrier Schottky (JBS) diodes, whose performance is strongly influenced by material quality, device architecture, and processing conditions. Topics such as Hall mobility, gated Hall measurements, gate oxide properties, gate dielectrics, and trench formation are examined to elucidate the relationship between interface quality and carrier transport.

A central focus is the reliability of gate structures under demanding operating conditions. Negative-bias gate stress, gate leakage, Fowler–Nordheim current, tunnelling phenomena, deep oxide traps, and bias temperature instability are discussed in detail, together with advanced diagnostic methods including charge pumping and Technology Computer-Aided Design (TCAD). These approaches provide insight into defect generation, threshold-voltage shifts, and long-term degradation mechanisms that affect device robustness.

The edition also addresses dynamic performance and application-oriented characteristics, including switching losses, dynamic losses, gate capacitance, parasitic capacitance, reverse recovery behaviour, and short-circuit reliability. Additional attention to explore ion-implanted phototransistors and emerging CMOS technologies based on SiC, highlighting the expanding role of wide-bandgap semiconductors beyond conventional applications.

This special edition presents the results of an evaluation of SiC power device performance and is intended as a valuable resource for researchers, engineers, and graduate students engaged in power semiconductor development and their reliability analysis. We hope that the knowledge presented in this volume will support continued innovation and accelerate the deployment of highly efficient and reliable SiC-based electronic systems.

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