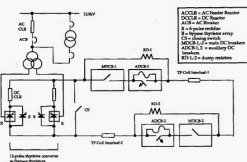


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### Design considerations and experimental analysis for silicon carbide power rectifiers

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**Abstract**  
In this paper we present the investigation of properties of silicon carbide power rectifiers, in particular Schottky, PN and advanced hybrid power rectifiers such as the trench MOS barrier Schottky rectifier. Analysis of the forward, reverse and switching experimental characteristics are presented and these silicon carbide rectifiers are compared to silicon devices. Silicon carbide Schottky rectifiers are attractive for applications requiring blocking voltage in excess of 100 V as the use of Si is precluded by its large specific on-resistance. Analysis of power dissipation indicates that silicon carbide Schottky rectifiers offer significant improvement over silicon counterparts. Silicon carbide junction rectifiers, on the other hand, are superior to silicon counterparts only for blocking voltage greater than 2000 V.  
Performance of acceptor (boron) and donor (phosphorus) implanted experimental silicon carbide junction rectifiers are presented and compared. Some of the recent developments in silicon carbide rectifiers have been described and compared with theory and our experimental results. The well established silicon rectifiers theory are often inadequate to describe the characteristics of the experimental silicon carbide junction rectifiers and appropriate generalization of these theories are presented. Experimental trench MOS barrier Schottky rectifiers (TMBS) have demonstrated significant improvement in leakage current compared to planar Schottky devices. Performance of current state-of-the-art silicon carbide rectifiers are far from theoretical predictions. Availability of high-quality silicon carbide crystals is crucial to successful realization of these performance projections. © 1999 Elsevier Science Ltd. All rights reserved.

#### 1. Introduction

Silicon (Si) has been the dominant material for the power semiconductor industry, due to native high quality insulator silicon dioxide (SiO<sub>2</sub>). No other semiconducting material can compete if a good high-quality insulating layer is required, i.e. for metal oxide

semiconductor (MOS) based devices. Gallium arsenide (GaAs), on the other hand, has been the workhorse of the microwave industry due to its high mobility, high carrier drift saturation velocity and availability of pure and high-quality crystals [1]. However, once the material is fixed the device performance can only be improved by development of new fabrication techniques and/or novel device structures, which is apparent with Si and GaAs [2]. With the continuous demand for high current and voltage handling capability and the ability to be able to operate devices at high frequencies and temperatures and in hostile en-

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