US006313482B1

(12) **United States Patent**
Baliga

(10) **Patent No.: US 6,313,482 B1**
(45) **Date of Patent: Nov. 6, 2001**

(54) **SILICON CARBIDE POWER DEVICES HAVING TRENCH-BASED SILICON CARBIDE CHARGE COUPLING REGIONS THEREIN**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/312,980**

(22) Filed: **May 17, 1999**

(51) **Int. Cl.**[7] **H01L 31/0312**

(52) **U.S. Cl.** **257/77**; 257/168; 257/266; 257/267; 257/279

(58) **Field of Search** 257/77, 168, 266, 257/267, 280, 339, 409, 471, 472, 487, 492, 493, 653, 654

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(57) **ABSTRACT**

Silicon carbide power devices having trench-based charge coupling regions include a silicon carbide substrate having a silicon carbide drift region of first conductivity type (e.g., N-type) and a trench therein at a first face thereof. A uniformly doped silicon carbide charge coupling region of second conductivity type (e.g., an in-situ doped epitaxial P-type region) is also provided in the trench. This charge coupling region forms a P-N rectifying junction with the drift region that extends along a sidewall of the trench. The drift region and charge coupling region are both uniformly doped at equivalent and relatively high net majority carrier doping concentrations (e.g., 1×10^{17} cm^{-3}) so that both the drift region and charge coupling region can be depleted substantially uniformly when blocking reverse voltages. This combination of preferred drift and charge coupling regions improves the electric field profile in the drift region to such an extent that very low forward on-state drift region resistance can be achieved simultaneously with very high reverse blocking voltage capability. Silicon carbide switching devices that can advantageously use the preferred combination of drift and charge coupling regions include Schottky barrier rectifiers (SBRs), junction field effect transistors (JFETs) and metal-oxide-semiconductor field effect transistors (MOSFETs).

17 Claims, 15 Drawing Sheets