US009543389B2

(12) **United States Patent**
Laven et al.

(10) **Patent No.: US 9,543,389 B2**
(45) **Date of Patent: Jan. 10, 2017**

(54) **SEMICONDUCTOR DEVICE WITH RECOMBINATION REGION**

(71) Applicant: **Infineon Technologies AG**, Neubiberg (DE)

(72) Inventors: **Johannes Georg Laven**, Taufkirchen (DE); **Roman Baburske**, Otterfing (DE); **Peter Kanschat**, Soest (DE)

(73) Assignee: **Infineon Technologies AG**, Neubiberg (DE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 79 days.

(21) Appl. No.: **14/102,955**

(22) Filed: **Dec. 11, 2013**

(65) **Prior Publication Data**

US 2015/0162407 A1 Jun. 11, 2015

(51) **Int. Cl.**

H01L 29/96	(2006.01)
H01L 29/10	(2006.01)
H01L 29/739	(2006.01)
H01L 29/78	(2006.01)
H01L 29/861	(2006.01)
H01L 29/423	(2006.01)
H01L 29/04	(2006.01)
H01L 29/06	(2006.01)
H01L 29/40	(2006.01)
H01L 29/417	(2006.01)

(52) **U.S. Cl.**

CPC ***H01L 29/1095*** (2013.01); ***H01L 29/04*** (2013.01); ***H01L 29/423*** (2013.01); ***H01L 29/7397*** (2013.01); ***H01L 29/7813*** (2013.01); ***H01L 29/861*** (2013.01); ***H01L 29/8613*** (2013.01); *H01L 29/0696* (2013.01); *H01L 29/407* (2013.01); *H01L 29/41766* (2013.01); *H01L 29/42368* (2013.01); *H01L 29/7396* (2013.01)

(58) **Field of Classification Search**

CPC H01L 29/10; H01L 29/739

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,476,712	B2 *	7/2013	Baburske	H01L 29/66136 257/362
2002/0093049	A1 *	7/2002	Tihanyi	H01L 29/7813 257/330
2002/0179976	A1 *	12/2002	Takahashi	H01L 29/407 257/370

(Continued)

OTHER PUBLICATIONS

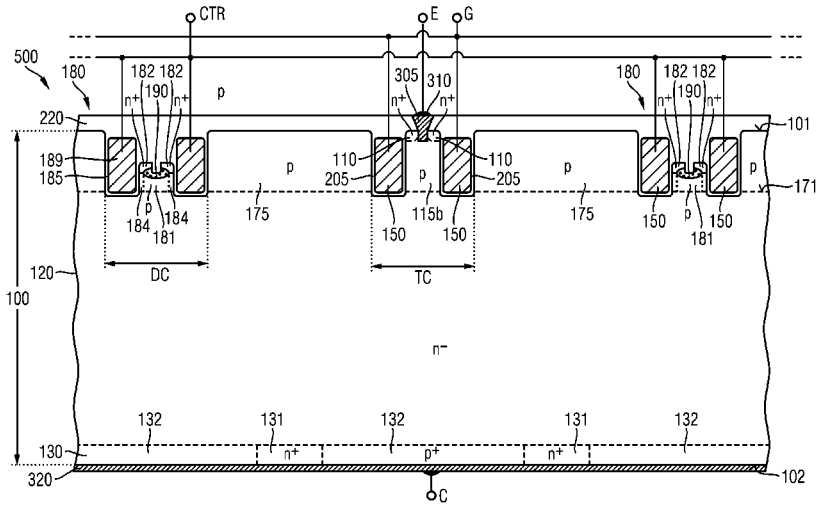
Laven, J.G., et al., "Semiconductor Device and Method for Forming a Semiconductor Device." U.S. Appl. No. 14/040,867, filed Sep. 30, 2013.

(Continued)

Primary Examiner — Earl Taylor

(74) *Attorney, Agent, or Firm* — Murphy, Bilak & Homiller, PLLC

(57) **ABSTRACT**

A semiconductor device includes a drift zone in a semiconductor body. A charge-carrier transfer region forms a pn junction with the drift zone in the semiconductor body. A control structure electrically connects a recombination region to the drift zone during a desaturation cycle and disconnects the recombination region from the drift zone outside the desaturation cycle. During the desaturation cycle the recombination region reduces a charge carrier plasma in the drift zone and reduces reverse recovery losses without adversely affecting blocking characteristics.

19 Claims, 16 Drawing Sheets