US007352016B2

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

(10) **Patent No.: US 7,352,016 B2**
(45) **Date of Patent: *Apr. 1, 2008**

(54) **GALLIUM NITRIDE MATERIAL TRANSISTORS AND METHODS ASSOCIATED WITH THE SAME**

(75) Inventors: **Walter H. Nagy**, Raleigh, NC (US); **Ricardo M. Borges**, Morrisville, NC (US); **Jeffrey D. Brown**, Garner, NC (US); **Apurva D. Chaudhari**, Raleigh, NC (US); **James W. Cook**, Raleigh, NC (US); **Allen W. Hanson**, Cary, NC (US); **Jerry Wayne Johnson**, Raleigh, NC (US); **Kevin J. Linthicum**, Angier, NC (US); **Edwin Lanier Piner**, Cary, NC (US); **Pradeep Rajagopal**, Raleigh, NC (US); **John Claassen Roberts**, Hillsborough, NC (US); **Sameer Singhal**, Apex, NC (US); **Robert Joseph Therrien**, Apex, NC (US); **Andrei Vescan**, Herzogenrath (DE)

(73) Assignee: **Nitronex Corporation**, Durham, NC (US)

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/598,551**

(22) Filed: **Nov. 13, 2006**

(65) **Prior Publication Data**

US 2007/0120147 A1 May 31, 2007

Related U.S. Application Data

(63) Continuation of application No. 10/913,297, filed on Aug. 5, 2004, now Pat. No. 7,135,720.

(60) Provisional application No. 60/493,039, filed on Aug. 5, 2003.

(51) **Int. Cl.**
H01L 31/00 (2006.01)

(52) **U.S. Cl.** **257/192**; 257/194

(58) **Field of Classification Search** 257/192, 257/194, 615

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,135,720 B2 * 11/2006 Nagy et al. 257/192

OTHER PUBLICATIONS

Nagy, W. et al., "Linearity Characteristics of Microwave Power GaN HEMTs," IEEE Transactions on Microwave Theory and Techniques, vol. 51, No. 2, Feb. 2003.*

* cited by examiner

Primary Examiner—Mark V. Prenty
(74) *Attorney, Agent, or Firm*—Wolf, Greenfield & Sacks, P.C.

(57) **ABSTRACT**

Gallium nitride material transistors and methods associated with the same are provided. The transistors may be used in power applications by amplifying an input signal to produce an output signal having increased power. The transistors may be designed to transmit the majority of the output signal within a specific transmission channel (defined in terms of frequency), while minimizing transmission in adjacent channels. This ability gives the transistors excellent linearity which results in high signal quality and limits errors in transmitted data. The transistors may be designed to achieve low ACPR values (a measure of excellent linearity), while still operating at high drain efficiencies and/or high output powers. Such properties enable the transistors to be used in RF power applications including third generation (3G) power applications based on W-CDMA modulation.

19 Claims, 11 Drawing Sheets