



# United States Patent [19]

Kusunoki et al.

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- [54] **FIELD EFFECT TRANSISTOR INCLUDING SILICON OXIDE FILM AND NITRIDED OXIDE FILM AS GATE INSULATOR FILM AND MANUFACTURING METHOD THEREOF**
- [75] Inventors: **Shigeru Kusunoki; Masahide Inuishi**, both of Hyogo-ken, Japan
- [73] Assignee: **Mitsubishi Denki Kabushiki Kaisha**, Tokyo, Japan
- [21] Appl. No.: **653,090**
- [22] Filed: **May 24, 1996**

### Related U.S. Application Data

- [60] Continuation of Ser. No. 341,952, Nov. 16, 1994, abandoned, which is a division of Ser. No. 930,932, Aug. 18, 1992, Pat. No. 5,369,297.

### Foreign Application Priority Data

- Sep. 5, 1991 [JP] Japan ..... 3-225686
- Dec. 6, 1991 [JP] Japan ..... 3-323239
- Jul. 3, 1992 [JP] Japan ..... 4-176873

- [51] Int. Cl.<sup>6</sup> ..... **H01L 21/265**
- [52] U.S. Cl. .... **437/40 GS; 437/41 GS; 437/42; 437/241**
- [58] Field of Search ..... **437/40 GS, 41 GS, 437/42, 241**

- [56] **References Cited**  
U.S. PATENT DOCUMENTS  
4,774,197 9/1988 Haddad et al. .... 437/24
- OTHER PUBLICATIONS**  
Kusunoki, "Hot-Carrier-resistant Structure By Re-Oxidized Nitrided Oxide Sidewall For Highly Reliable and High Performance LDD MOSFETS", IEDM, IEEE, pp. 649-652. 1991.
- Primary Examiner*—Charles L. Bowers, Jr.  
*Assistant Examiner*—Lynne A. Gurley  
*Attorney, Agent, or Firm*—Lowe, Price, LeBlanc & Becker
- [57] **ABSTRACT**

An N type field effect transistor having a higher resistivity to hot carriers and exhibiting a higher current handling capability even when used at a low gate voltage, and a method of manufacturing such a transistor are provided. A nitrided oxide film is formed on a drain avalanche hot carrier injection region. The nitrided oxide film is highly resistive to drain avalanche hot carriers as compared to a silicon oxide film. The silicon oxide film is formed on a channel hot electron injection region. The silicon oxide film is highly resistive to channel hot electrons as compared to the nitrided oxide film. A major portion of a gate insulator film is a silicon oxide film. The silicon oxide film exhibits a higher current handling capability at a low gate voltage as compared to the nitrided oxide film.

7 Claims, 39 Drawing Sheets

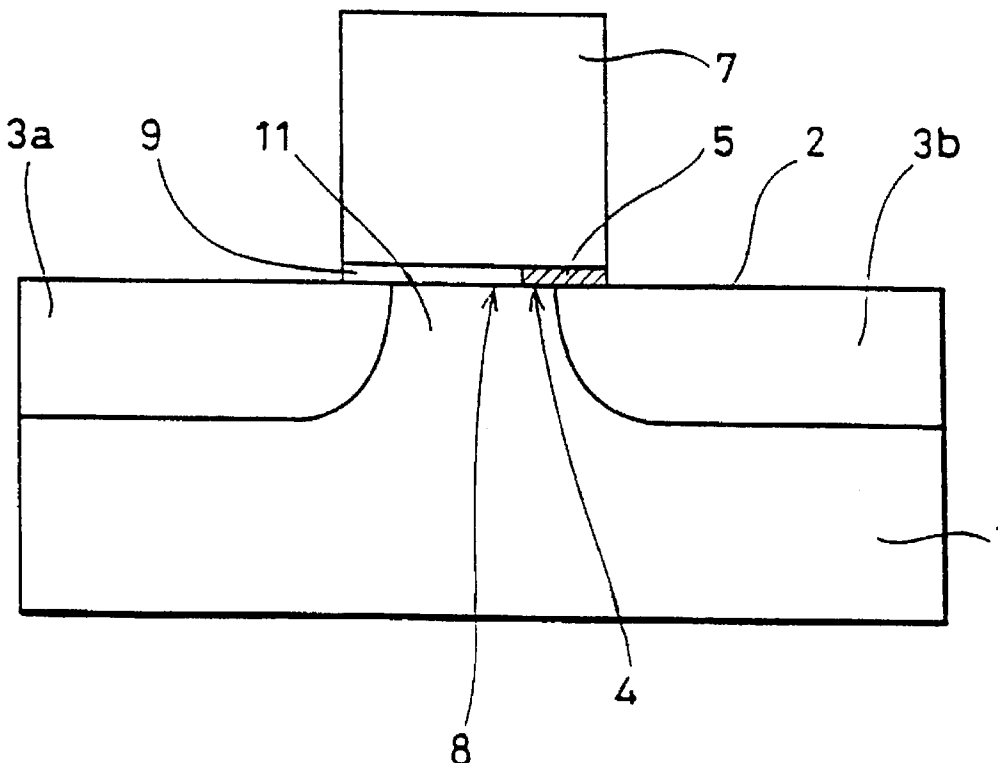


FIG. 1

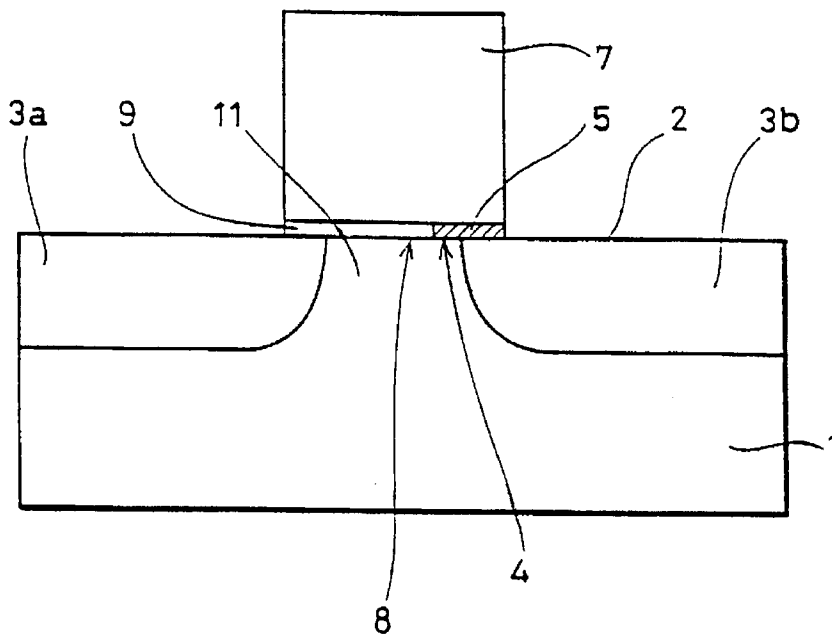


FIG. 2

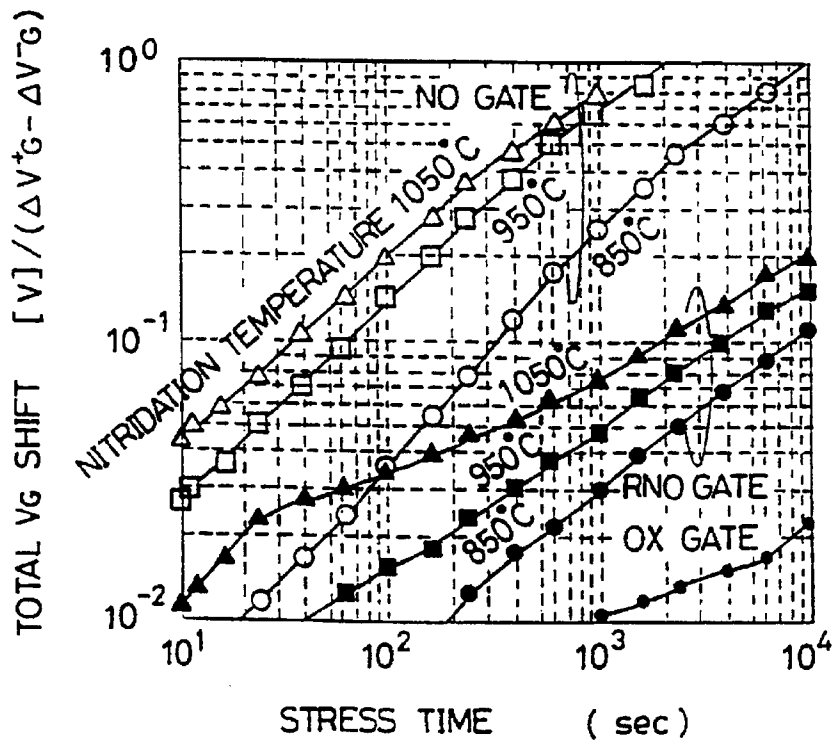


FIG. 3 PRIOR ART

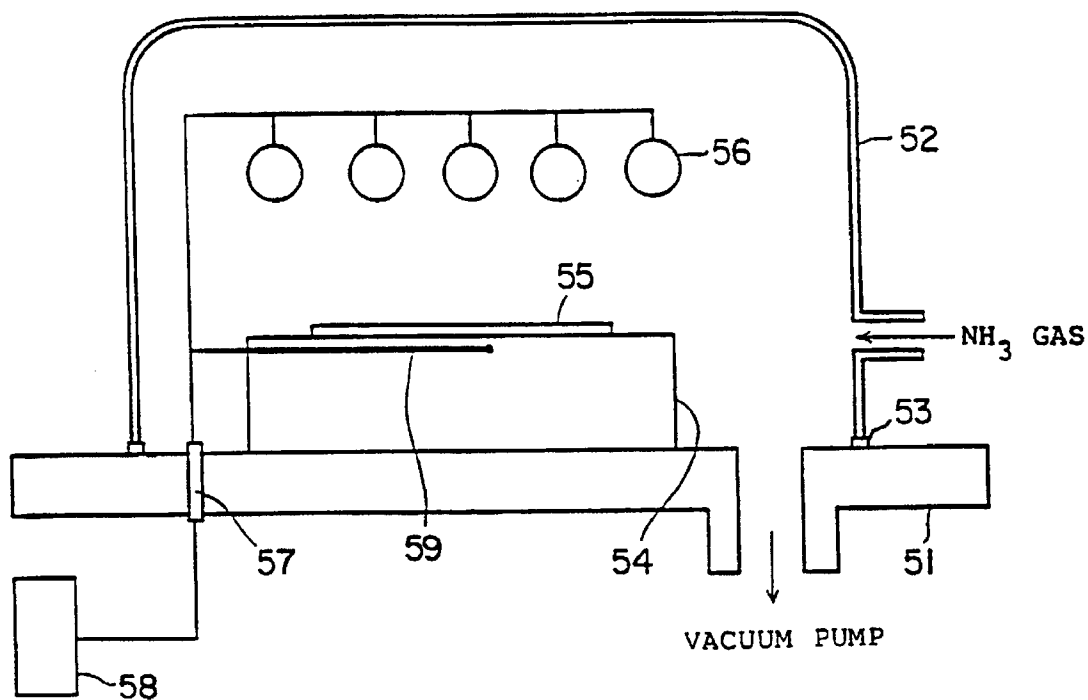


FIG. 4

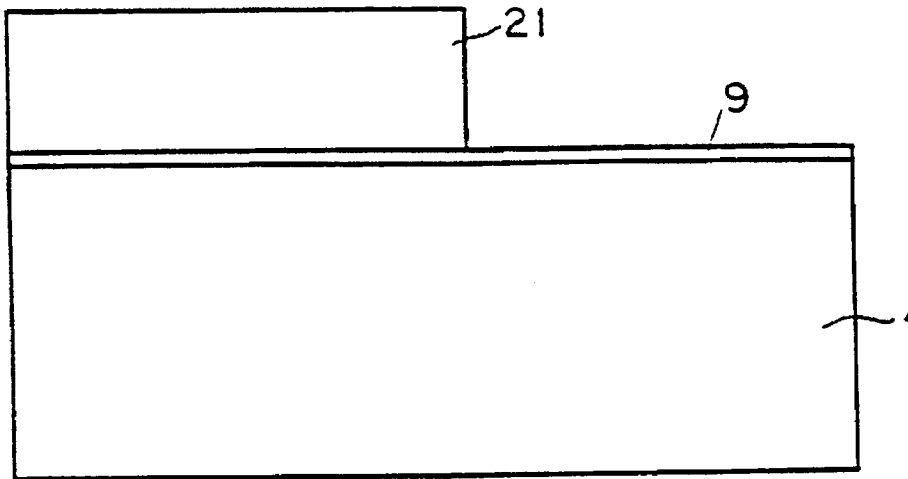


FIG. 5

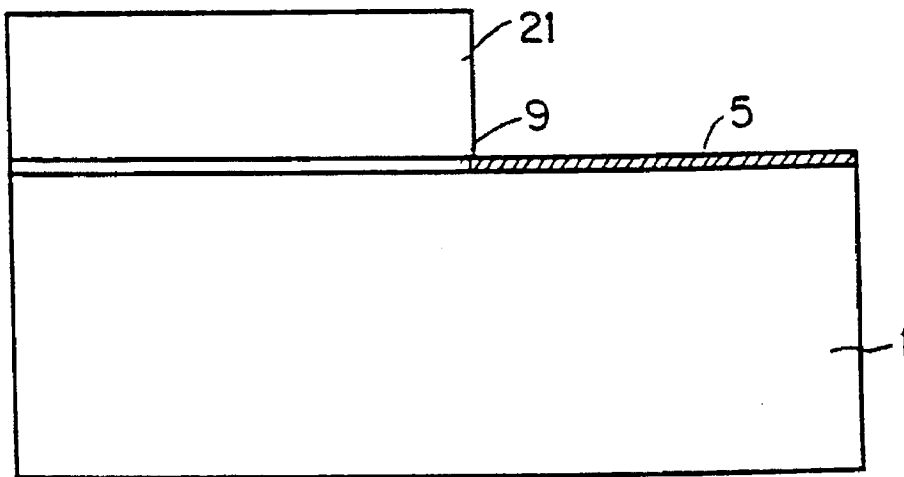


FIG. 6

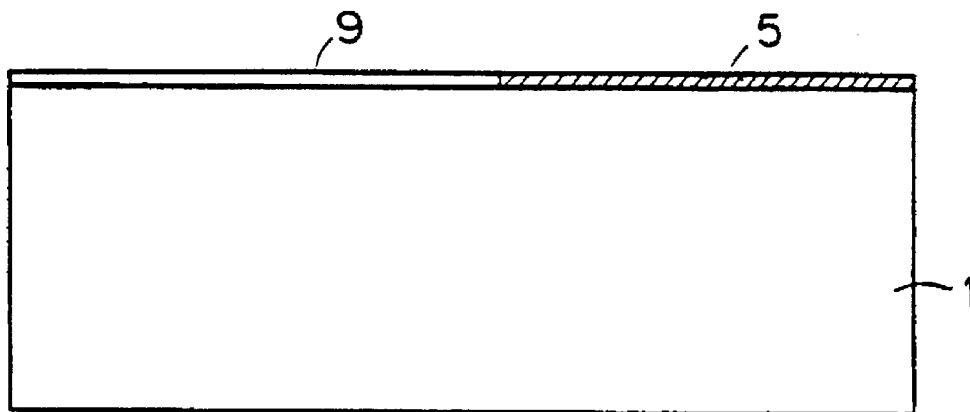
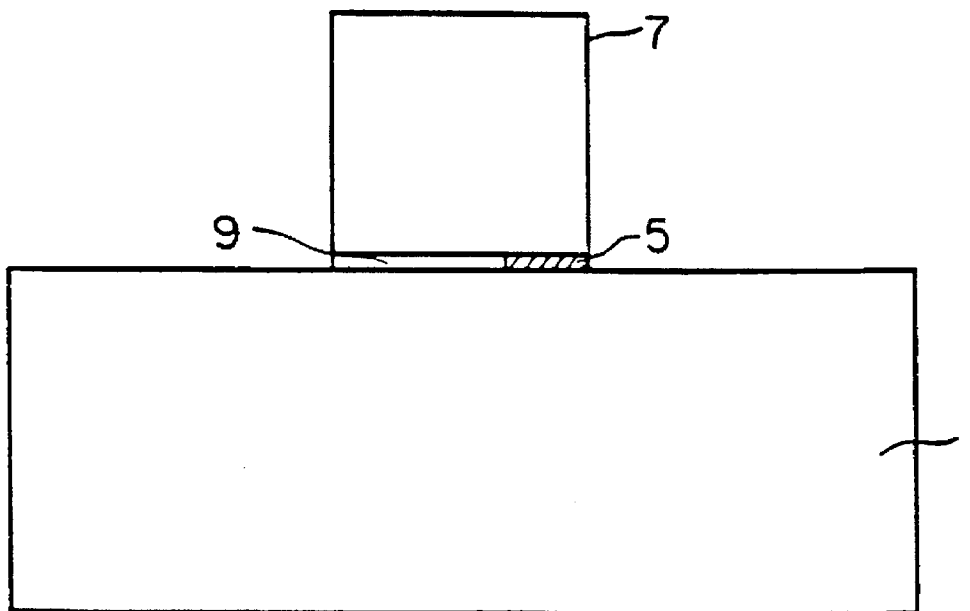


FIG. 7



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