



US007893501B2

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

(10) **Patent No.:** US 7,893,501 B2
(45) **Date of Patent:** *Feb. 22, 2011

(54) **SEMICONDUCTOR DEVICE INCLUDING MISFET HAVING INTERNAL STRESS FILM**

(75) Inventors: **Masafumi Tsutsui**, Osaka (JP); **Hiroyuki Umimoto**, Hyogo (JP); **Kaori Akamatsu**, Osaka (JP)

(73) Assignee: **Panasonic Corporation**, Osaka (JP)

(*) 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.: **12/170,191**

(22) Filed: **Jul. 9, 2008**

(65) **Prior Publication Data**
US 2009/0050981 A1 Feb. 26, 2009

Related U.S. Application Data
(63) Continuation of application No. 11/730,988, filed on Apr. 5, 2007, now Pat. No. 7,417,289, which is a continuation of application No. 10/859,219, filed on Jun. 3, 2004, now Pat. No. 7,205,615.

(30) **Foreign Application Priority Data**
Jun. 16, 2003 (JP) 2003-170335

(51) **Int. Cl.**
H01L 29/76 (2006.01)
H01L 29/94 (2006.01)
H01L 31/062 (2006.01)
H01L 31/113 (2006.01)
H01L 31/119 (2006.01)

(52) **U.S. Cl.** 257/369
(58) **Field of Classification Search** 257/369
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,023,676 A 6/1991 Tatsuta

(Continued)

FOREIGN PATENT DOCUMENTS

JP 52-120776 10/1977

(Continued)

OTHER PUBLICATIONS

Shimizu, A., et al., "Local Mechanical-Stress Control (LMC): A New Technique for CMOS_Performance Enhancement", 2001, IEDM 01, p. 19.4.1-19.4.4.

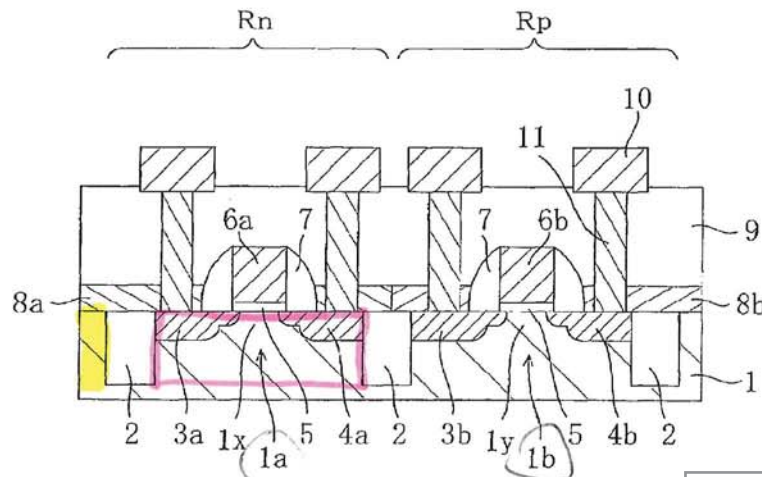
(Continued)

Primary Examiner—Howard Weiss
(74) *Attorney, Agent, or Firm*—McDermott Will & Emery LLP

(57) **ABSTRACT**

A semiconductor device includes a first-type internal stress film formed of a silicon oxide film over source/drain regions of an nMISFET and a second-type internal stress film formed of a TEOS film over source/drain regions of a pMISFET. In a channel region of the nMISFET, a tensile stress is generated in the direction of movement of electrons due to the first-type internal stress film, so that the mobility of electrons is increased. In a channel region of the pMISFET, a compressive stress is generated in the direction of movement of holes due to the second-type internal stress film, so that the mobility of holes is increased.

25 Claims, 9 Drawing Sheets



IP Bridge Exhibit 2021

US 7,893,501 B2

Page 2

U.S. PATENT DOCUMENTS

6,437,404 B1 * 8/2002 Xiang et al. 257/347
6,573,172 B1 6/2003 En et al.
6,870,230 B2 * 3/2005 Matsuda et al. 257/365
6,977,194 B2 12/2005 Belyansky et al.
6,982,465 B2 1/2006 Kumagai et al.
7,022,561 B2 4/2006 Huang et al.
7,205,615 B2 * 4/2007 Tsutsui et al. 257/369
7,417,289 B2 * 8/2008 Tsutsui et al. 257/369
2003/0040158 A1 2/2003 Saitoh
2004/0075148 A1 4/2004 Kumagai et al.

2005/0194596 A1 9/2005 Chan et al.

FOREIGN PATENT DOCUMENTS

JP 60-236209 11/1985
JP 01-042840 A 2/1989
JP 2003-086708 3/2003
JP 2004-193166 7/2004

OTHER PUBLICATIONS

Japanese Office Action, with English translation, issued in Japanese Patent Application No. 2003-170335, mailed Dec. 22, 2009.

Japanese Office Action, with English translation, issued in Japanese Patent Application No. 2003-170335, mailed Mar. 23, 2010.

* cited by examiner

FIG. 1

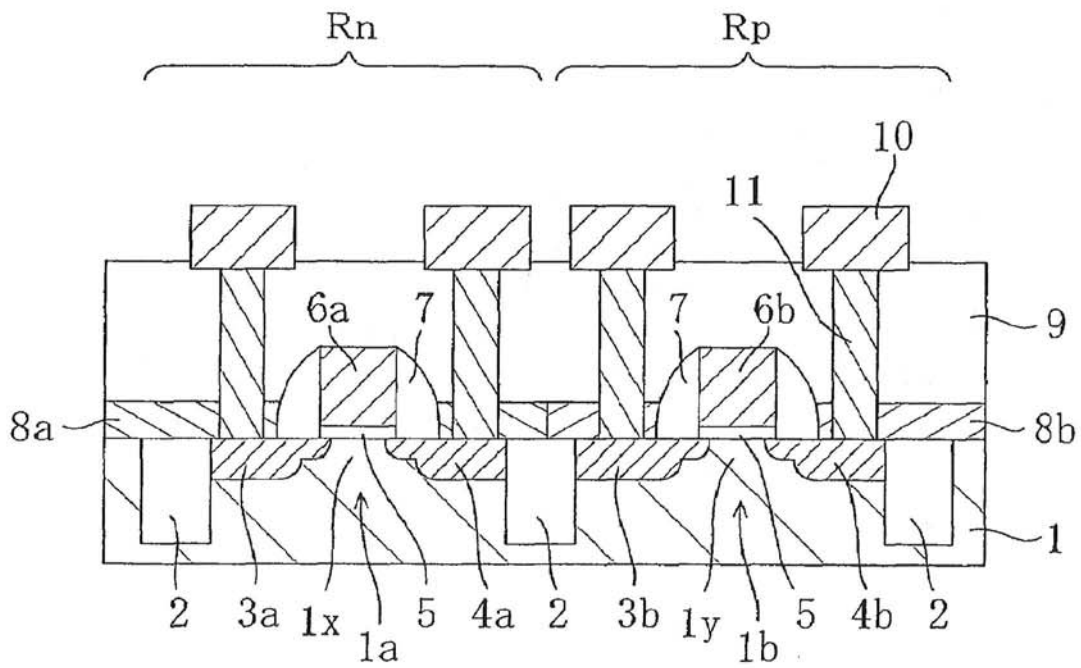


FIG. 2A

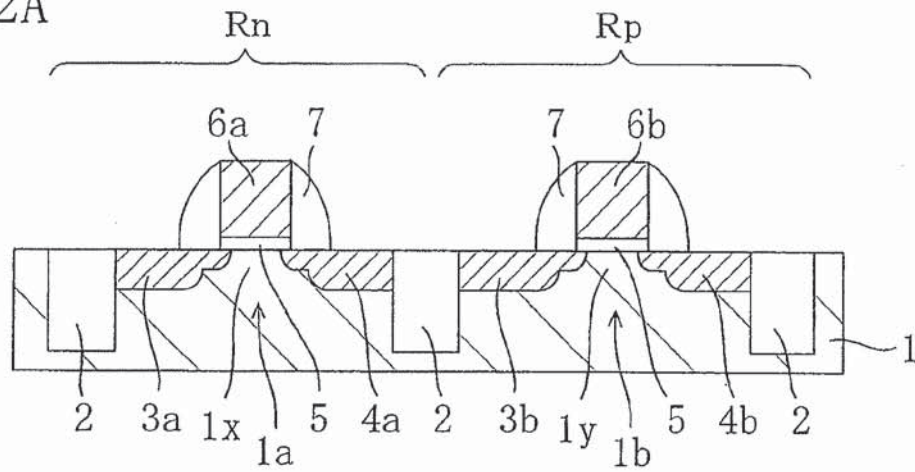


FIG. 2B

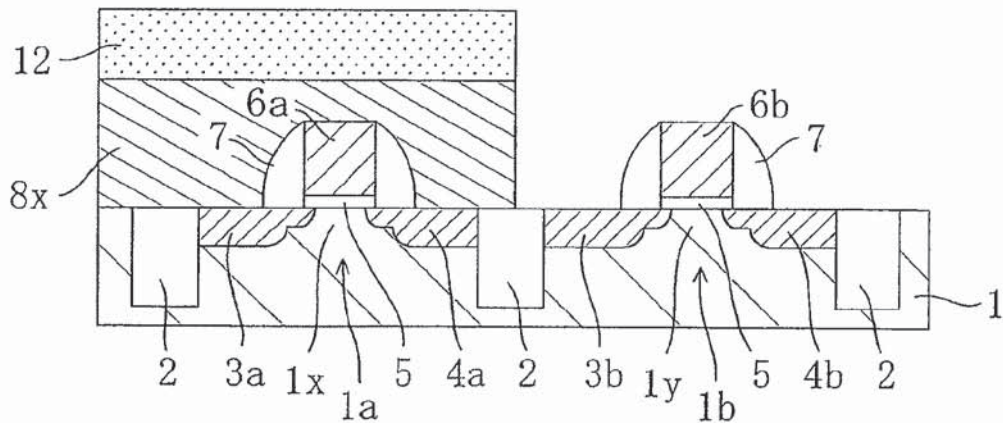


FIG. 2C

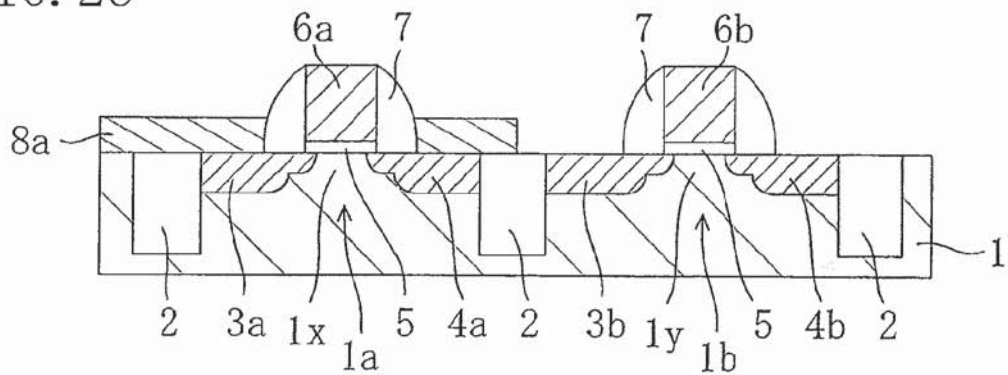


FIG. 3A

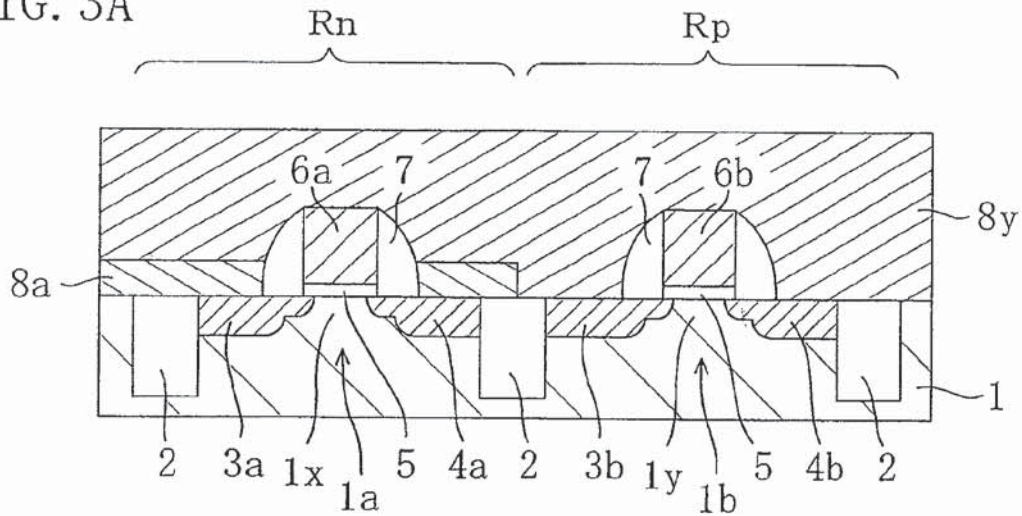


FIG. 3B

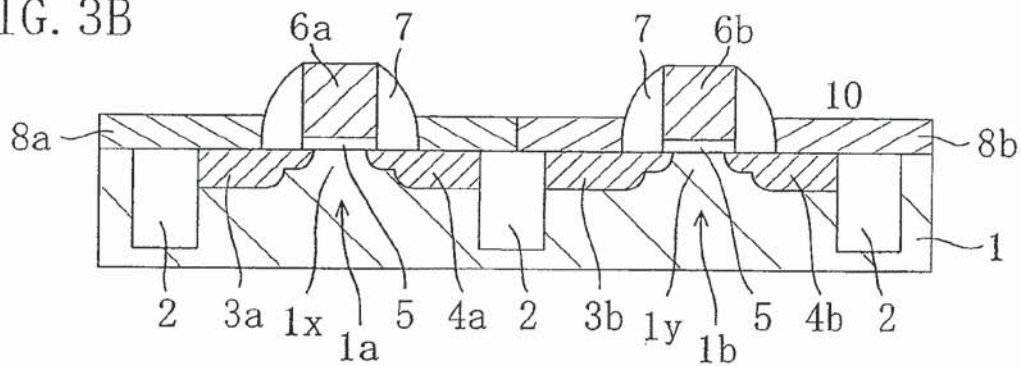
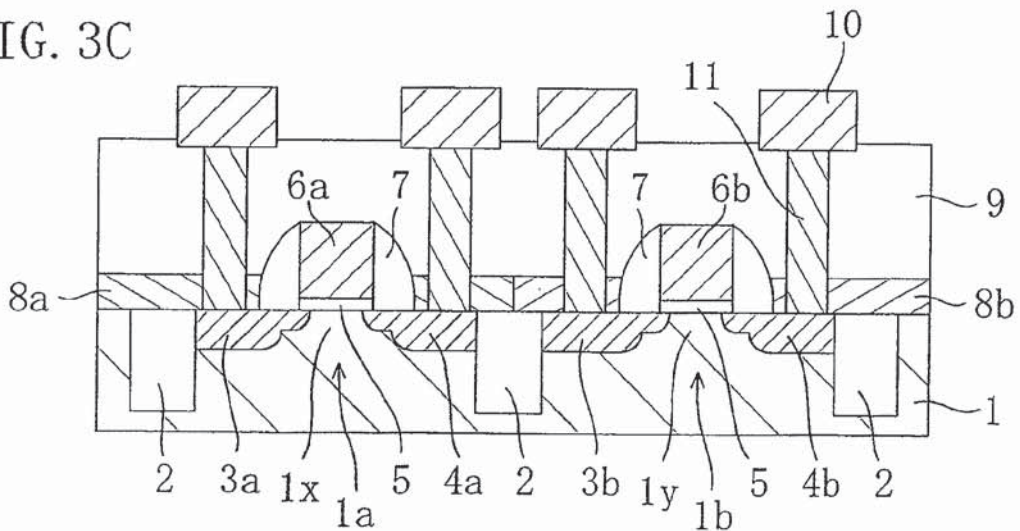


FIG. 3C



Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.