



US005592024A

# United States Patent [19]

Aoyama et al.

[11] Patent Number: **5,592,024**

[45] Date of Patent: **Jan. 7, 1997**

[54] SEMICONDUCTOR DEVICE HAVING A WIRING LAYER WITH A BARRIER LAYER

[75] Inventors: **Hisako Aoyama**, Kawasaki; **Kyoichi Suguro**, Yokohama; **Hiromi Niiyama**, Yokohama; **Hitoshi Tamura**, Yokohama; **Hisataka Hayashi**, Yokohama; **Tomonori Aoyama**; **Gaku Minamihaba**, both of Kawasaki; **Tadashi Iijima**, Yokohama, all of Japan

[73] Assignee: **Kabushiki Kaisha Toshiba**, Kawasaki, Japan

[21] Appl. No.: **330,998**

[22] Filed: **Oct. 28, 1994**

[30] Foreign Application Priority Data

Oct. 29, 1993	[JP]	Japan	.....	5-272784
Mar. 15, 1994	[JP]	Japan	.....	6-070156
Sep. 19, 1994	[JP]	Japan	.....	6-249984

[51] Int. Cl.<sup>6</sup> ..... **H01L 23/535**; H01L 29/41; H01L 29/43

[52] U.S. Cl. .... **257/751**; 257/752; 257/760; 257/763; 257/764; 257/762; 257/915

[58] Field of Search ..... 257/750-753, 257/759, 760, 762, 773, 763, 764, 915

[56] References Cited

U.S. PATENT DOCUMENTS

4,091,406	5/1978	Lewis	.....	257/760
4,789,648	12/1988	Chow et al.	.....	437/225
5,300,813	4/1994	Joshi et al.	.....	257/752

FOREIGN PATENT DOCUMENTS

0040745	12/1970	Japan	.	
0040515	10/1972	Japan	.	
0242331	10/1987	Japan	.....	257/760
0082653	3/1989	Japan	.....	257/760
2-78769	11/1990	Japan	.....	257/760
0270256	12/1991	Japan	.....	257/760
0343541	12/1993	Japan	.....	257/760

OTHER PUBLICATIONS

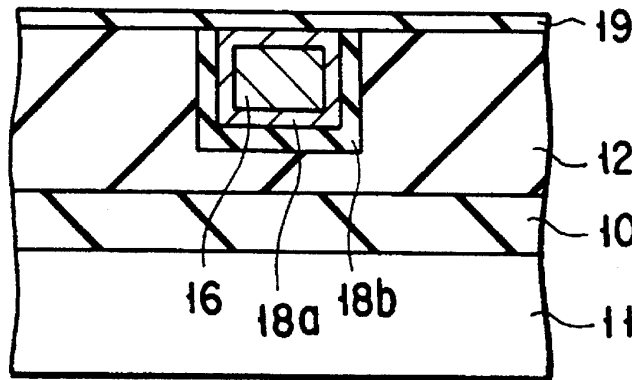
IBMTDB, Lithographic Patterns With a Barrier Liner, vol. 32, No. 103, Mar. 1990, pp. 114-115.  
IBMTDB, Copper Multilevel Interconnections, vol. 33, No. 11, Apr. 1991, pp. 299-300.  
IBMTDB, AG Metallurgy System for Integrated Circuit Devices vol. 13, No. 2, Jul. 1970, pp. 511-512.

Primary Examiner—Peter Toby Brown  
Attorney, Agent, or Firm—Oblon, Spivak, McClelland, Maier & Neustadt, P.C.

[57] ABSTRACT

A semiconductor device comprises a semiconductor substrate in which a semiconductor element is formed, an interlayer insulating film formed on the semiconductor substrate, an insulating barrier layer, formed on the interlayer insulating film by plasma nitriding, for preventing diffusion of a metal constituting a wiring layer, a conductive barrier layer, formed on the insulating barrier layer, for preventing diffusion of the metal, and a wiring layer formed of the metal on the conductive barrier layer. A bottom portion of the wiring layer is protected by the conductive barrier layer and the insulating barrier layer. Therefore, the diffusion of the metal constituting the wiring layer can be surely prevented.

5 Claims, 35 Drawing Sheets



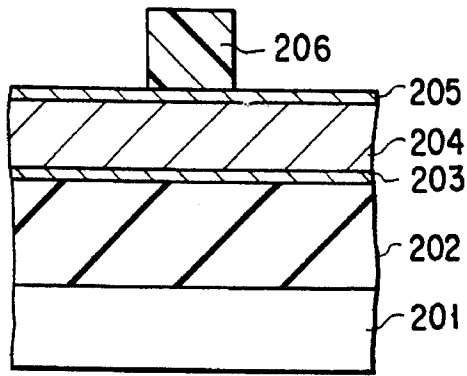


FIG. 1A PRIOR ART

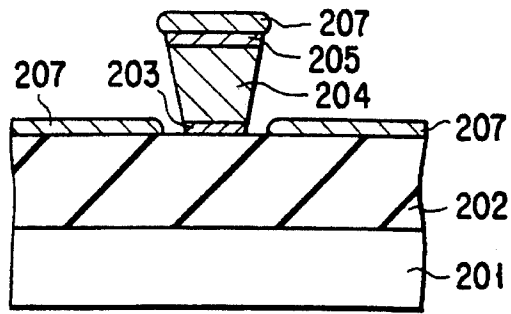


FIG. 2A PRIOR ART

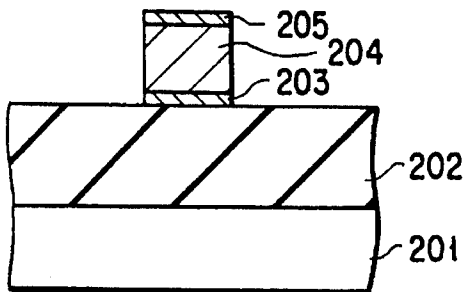


FIG. 1B PRIOR ART

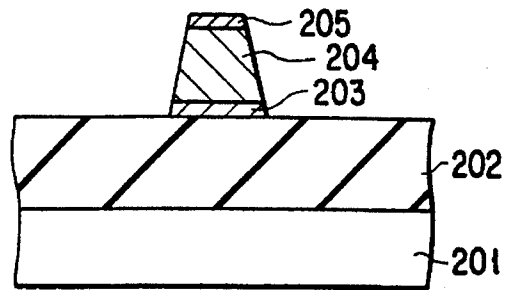


FIG. 2B PRIOR ART

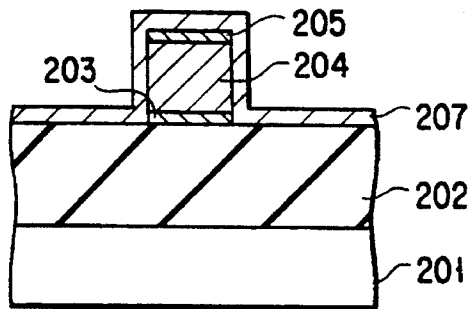


FIG. 1C PRIOR ART

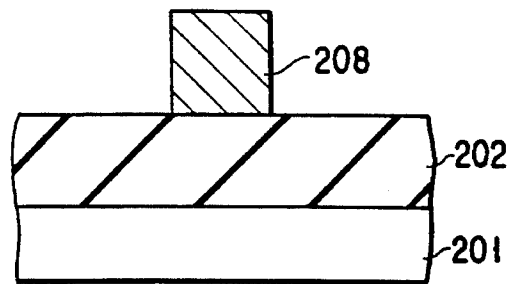


FIG. 3A PRIOR ART

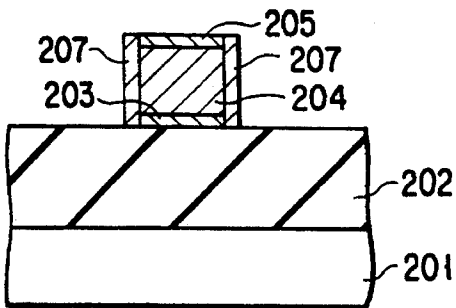


FIG. 1D PRIOR ART

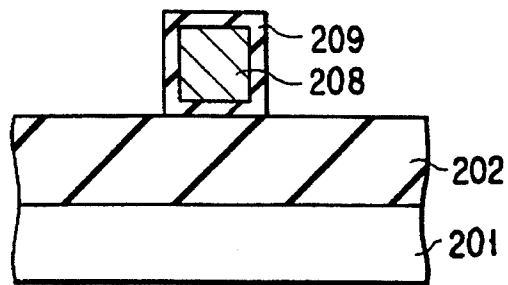


FIG. 3B PRIOR ART

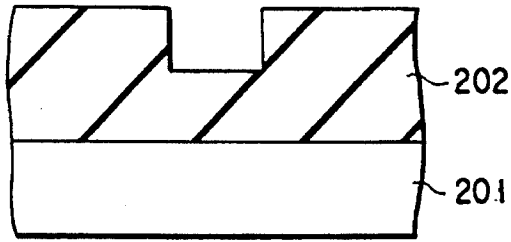


FIG. 4A PRIOR ART

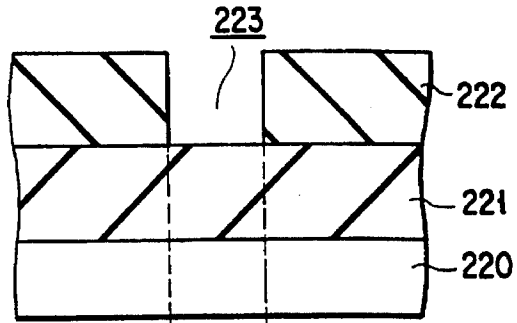


FIG. 5A PRIOR ART

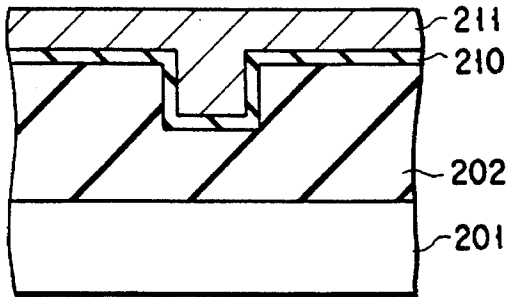


FIG. 4B PRIOR ART

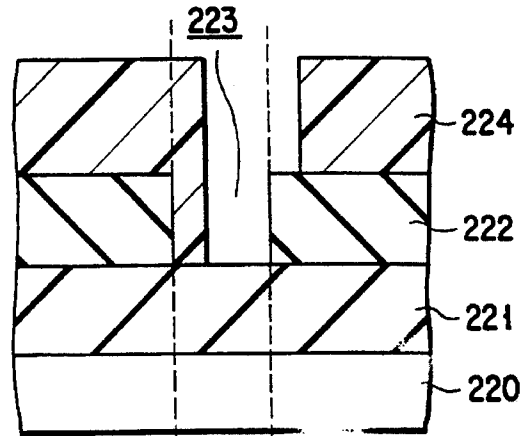


FIG. 5B PRIOR ART

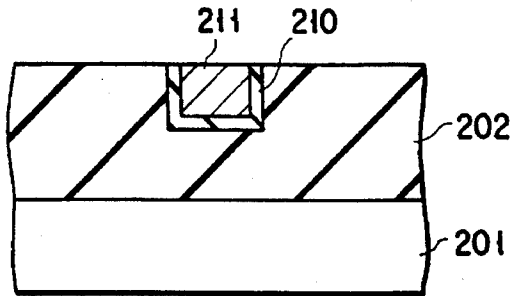


FIG. 4C PRIOR ART

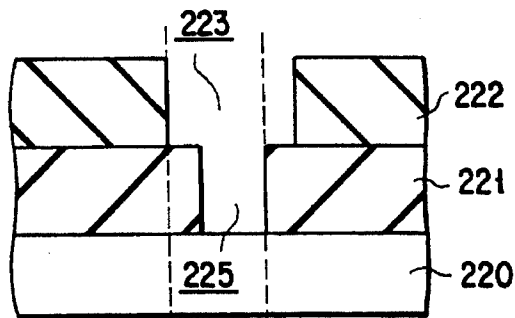


FIG. 5C PRIOR ART

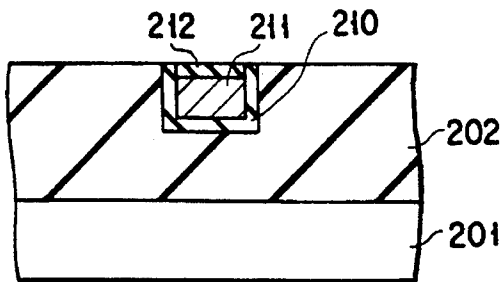


FIG. 4D PRIOR ART

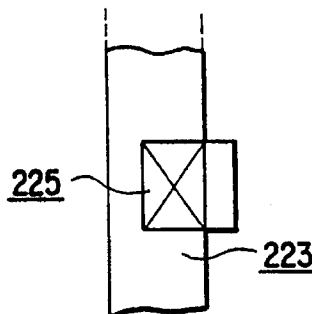
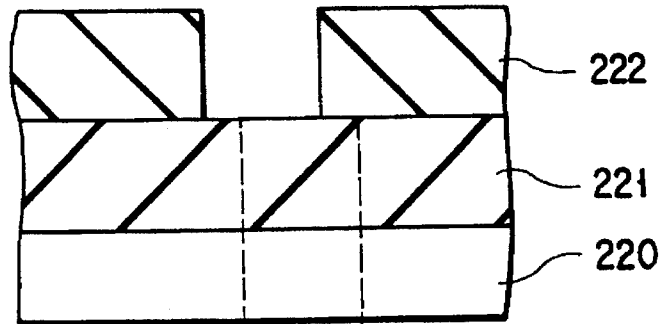
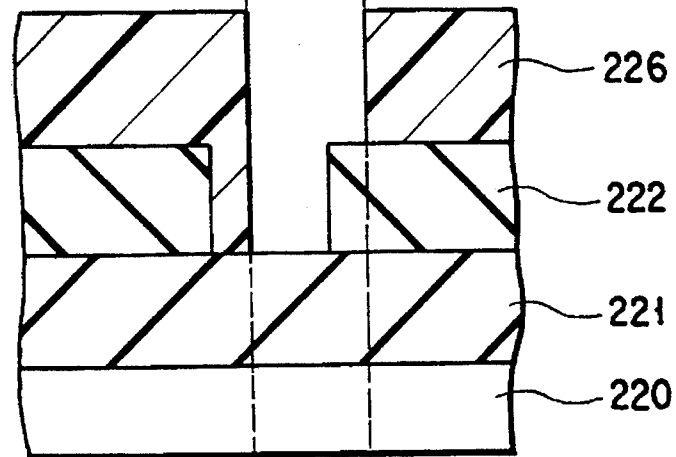


FIG. 5D PRIOR ART

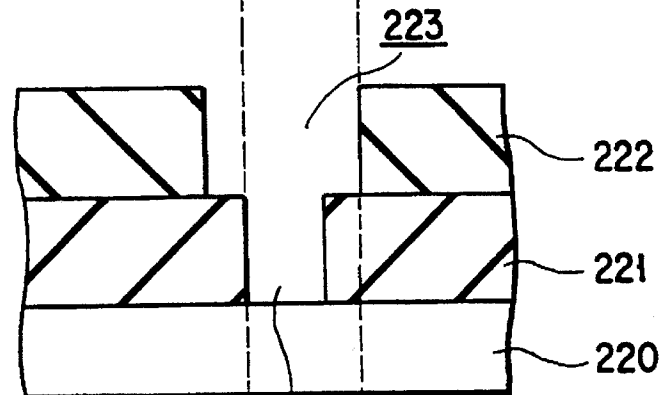
PRIOR ART  
FIG. 6A



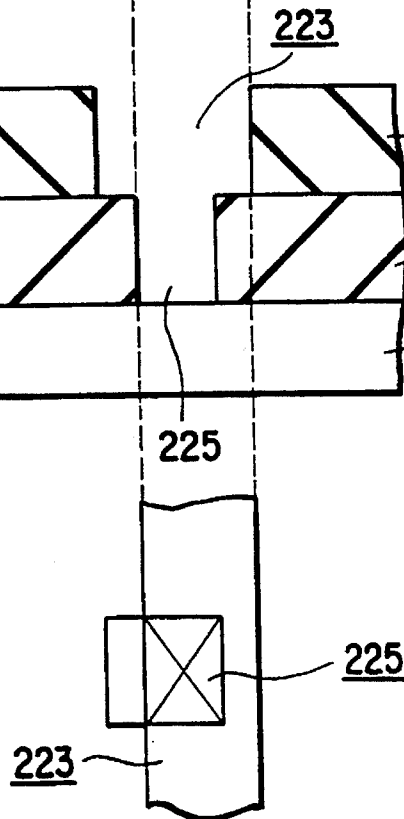
PRIOR ART  
FIG. 6B



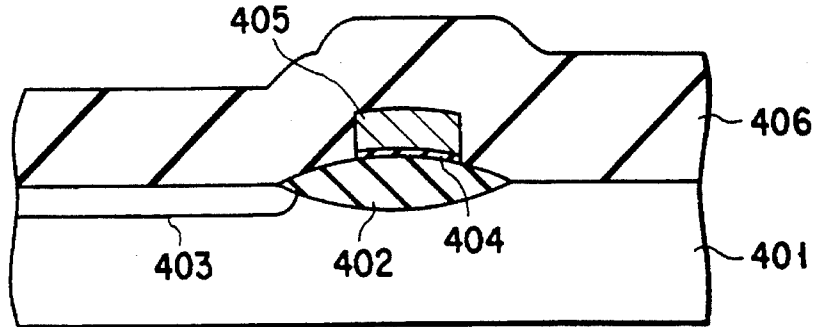
PRIOR ART  
FIG. 6C



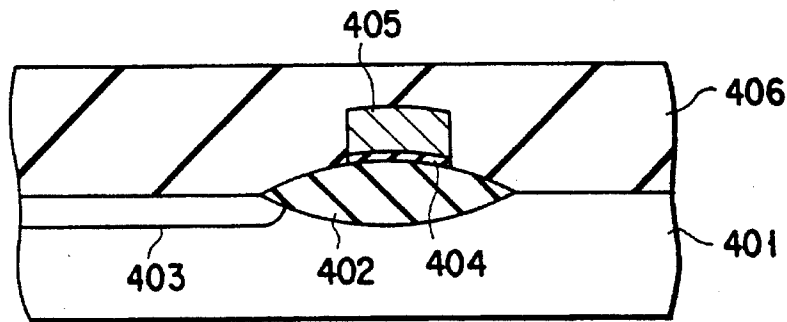
PRIOR ART  
FIG. 6D



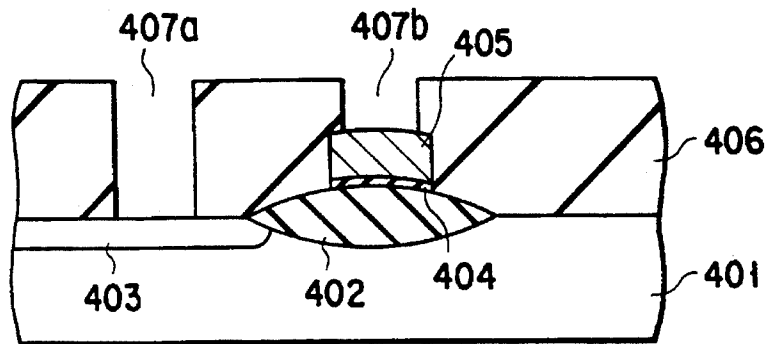
PRIOR ART  
FIG. 7A



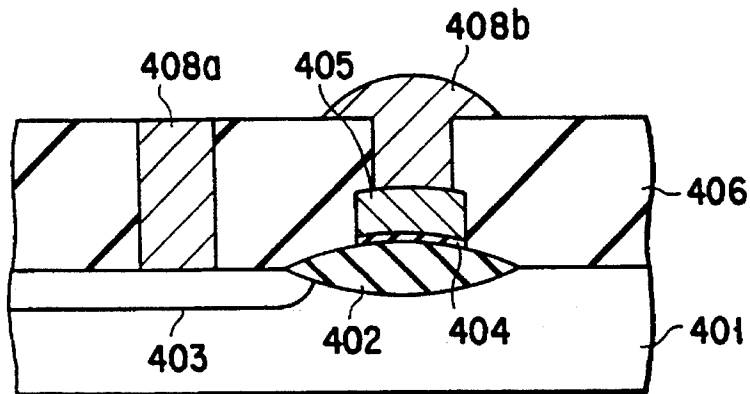
PRIOR ART  
FIG. 7B



PRIOR ART  
FIG. 7C



PRIOR ART  
FIG. 7D



# 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.