



US006197696B1

(12) **United States Patent**  
**Aoi**

(10) **Patent No.:** **US 6,197,696 B1**  
(45) **Date of Patent:** **Mar. 6, 2001**

(54) **METHOD FOR FORMING INTERCONNECTION STRUCTURE**

- (75) Inventor: **Nobuo Aoi**, Hyogo (JP)
- (73) Assignee: **Matsushita Electric Industrial Co., Ltd.**, 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.

- (21) Appl. No.: **09/274,114**
  - (22) Filed: **Mar. 23, 1999**
  - (30) **Foreign Application Priority Data**
- |                                   |      |                         |
|-----------------------------------|------|-------------------------|
| Mar. 26, 1998                     | (JP) | 10-079371               |
| (51) <b>Int. Cl.</b> <sup>7</sup> |      | <b>H01L 21/311</b>      |
| (52) <b>U.S. Cl.</b>              |      | <b>438/700; 438/706</b> |
| (58) <b>Field of Search</b>       |      | <b>438/700, 706</b>     |

- (56) **References Cited**
- U.S. PATENT DOCUMENTS**
- |           |           |                 |         |
|-----------|-----------|-----------------|---------|
| 5,110,712 | 5/1992    | Kessler et al.  | 438/623 |
| 5,518,963 | * 5/1996  | Park            | 438/624 |
| 5,635,423 | * 6/1997  | Huang et al.    | 438/638 |
| 5,651,855 | 7/1997    | Dennison et al. | 438/628 |
| 5,702,982 | * 12/1997 | Lee et al.      | 438/620 |
- FOREIGN PATENT DOCUMENTS**
- |              |         |      |              |
|--------------|---------|------|--------------|
| 0 425 787 A2 | 5/1991  | (EP) | H01L/21/90   |
| 0 680 085 A1 | 11/1995 | (EP) | H01L/21/768  |
| 6-291193     | 10/1994 | (JP) | H01L/21/90   |
| 7-153842     | 6/1995  | (JP) | H01L/21/768  |
| 9-64034      | 3/1997  | (JP) | H01L/21/3205 |
| 9-153545     | 6/1997  | (JP) | H01L/21/768  |

**OTHER PUBLICATIONS**

European Search Report dated Jul. 1, 1999.  
\* cited by examiner

*Primary Examiner*—Benjamin L. Utech  
*Assistant Examiner*—Lynette T. Umez-Eronini  
(74) *Attorney, Agent, or Firm*—Eric J. Robinson; Nixon Peabody LLP

(57) **ABSTRACT**

In a method for forming an interconnection structure, first, second and third insulating films and a thin film are sequentially formed over lower-level metal interconnects. Then, the thin film is masked with a first resist pattern and etched to form a mask pattern with openings for interconnects. Next, the third insulating film is masked with a second resist pattern and dry-etched such that the third insulating film and the first and second resist patterns are etched at a high rate and that the second insulating film is etched at a low rate to form openings for contact holes in the third insulating film and remove the first and second resist patterns. Then, the second insulating film is masked with the third insulating film and dry-etched such that the second insulating film is etched at a high rate and that the first and third insulating films are etched at a low rate to form the openings for contact holes in the second insulating film. Then, the third and first insulating films are masked with the mask pattern and the second insulating film, respectively, and dry-etched such that the first and third insulating films are etched at a high rate and that the mask pattern and the second insulating film are etched at a low rate to form wiring grooves and contact holes in the third and first insulating films, respectively. Finally, upper-level metal interconnects and contacts are formed.

**15 Claims, 37 Drawing Sheets**

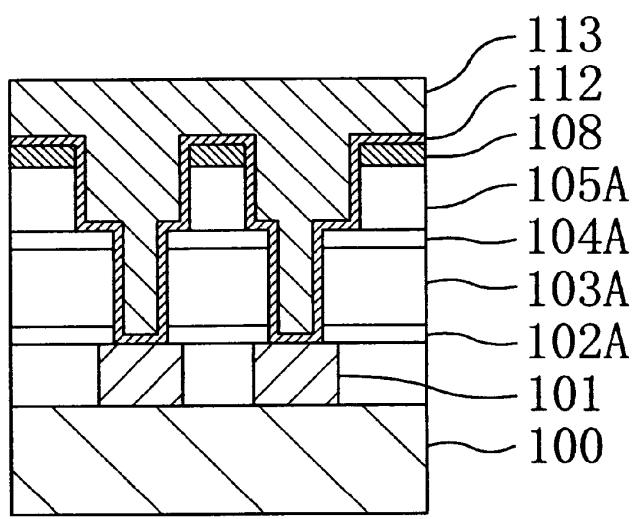


Fig. 1 (a)

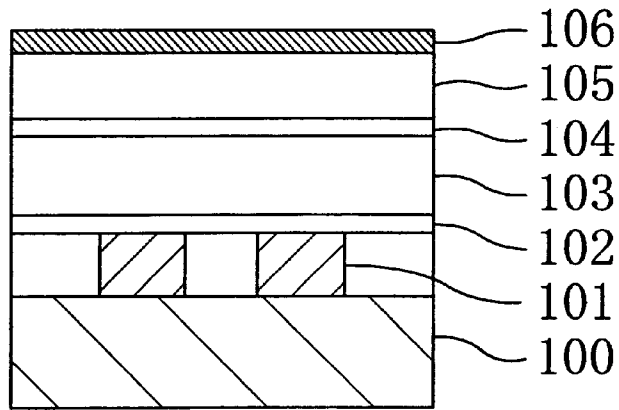


Fig. 1 (b)

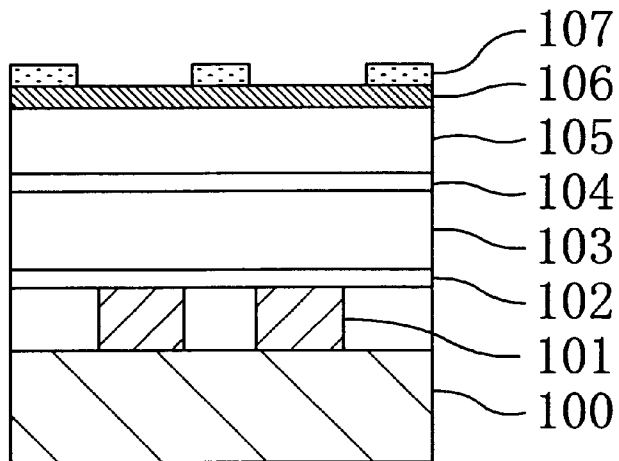


Fig. 1 (c)

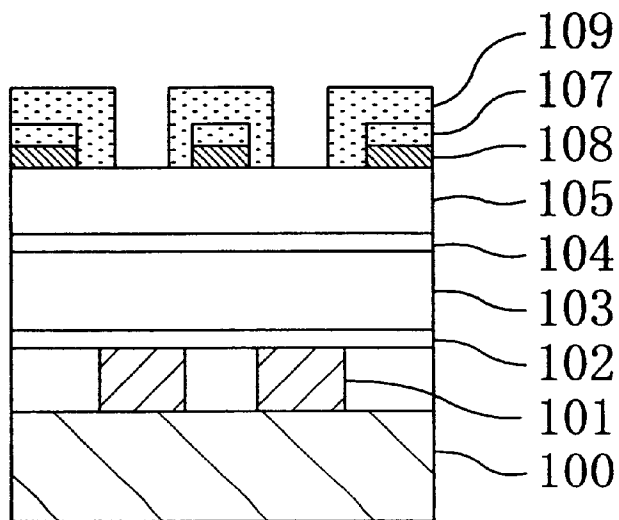


Fig. 2(a)

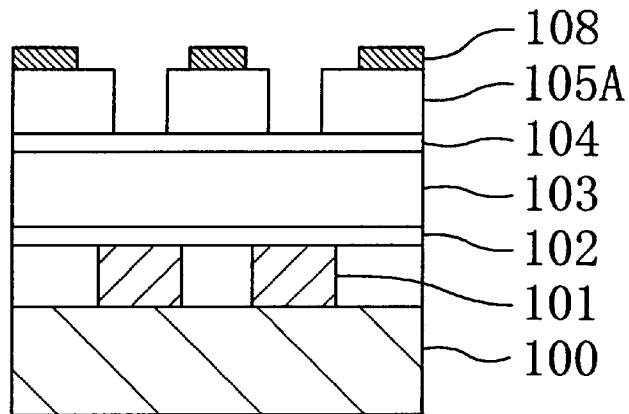


Fig. 2(b)

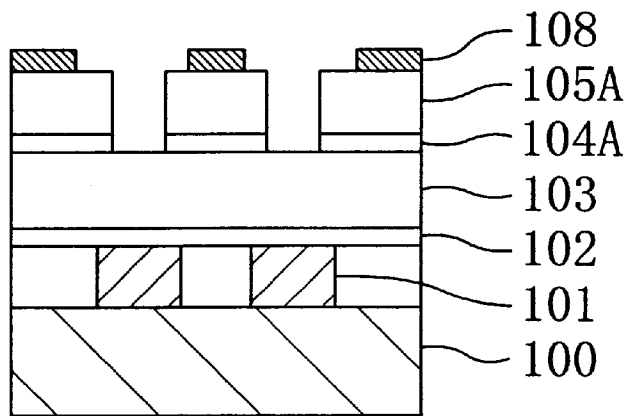


Fig. 2(c)

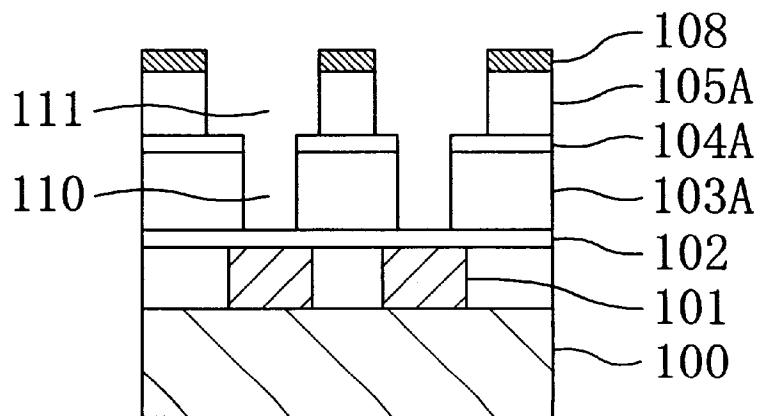


Fig. 3(a)

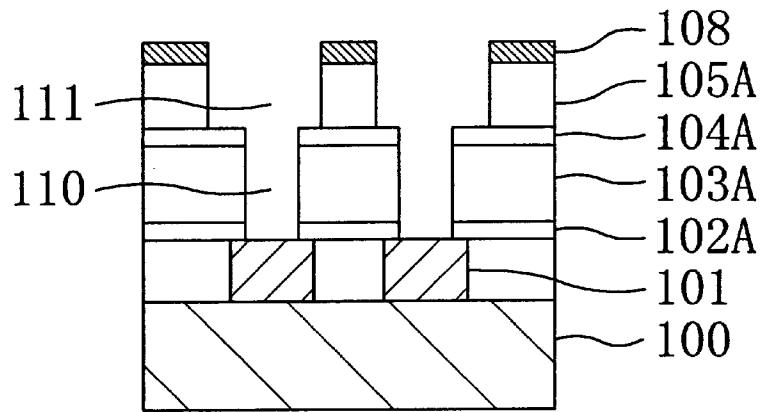


Fig. 3(b)

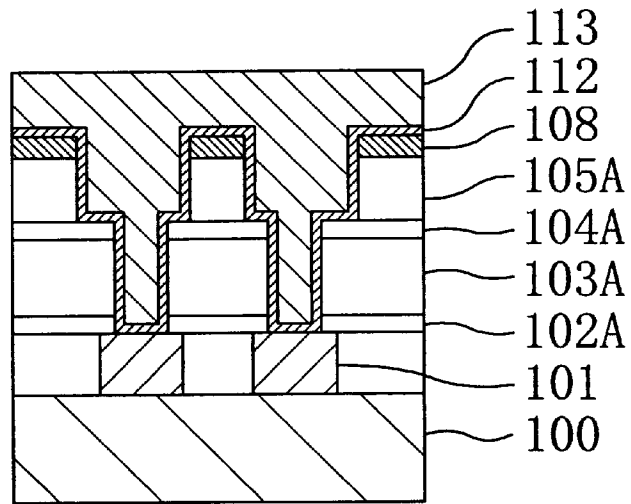


Fig. 3(c)

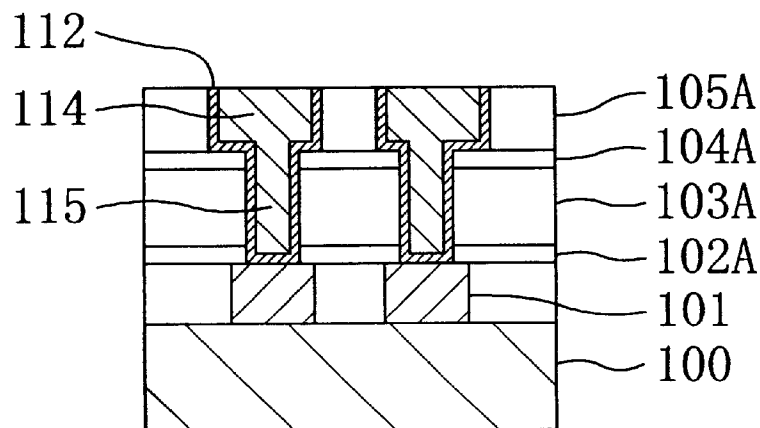


Fig. 4(a)

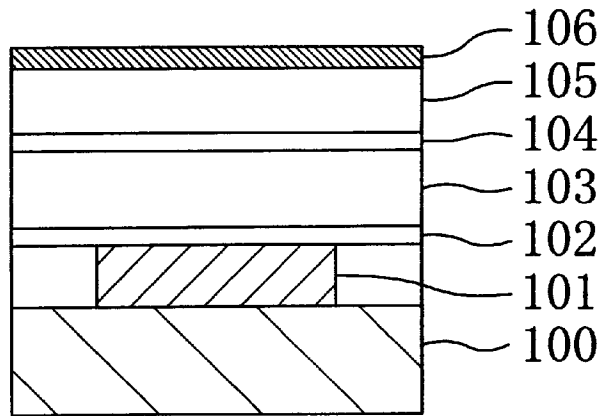


Fig. 4(b)

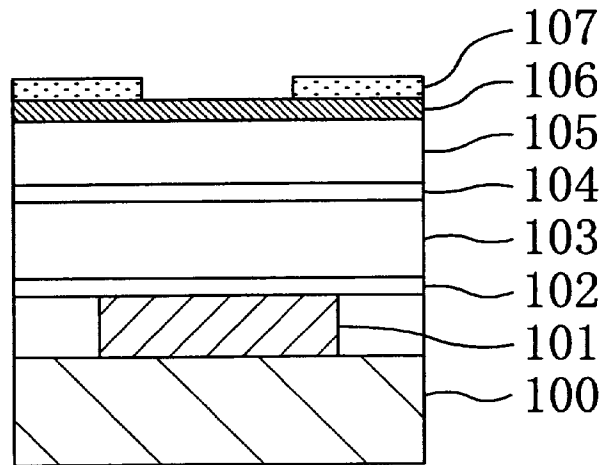
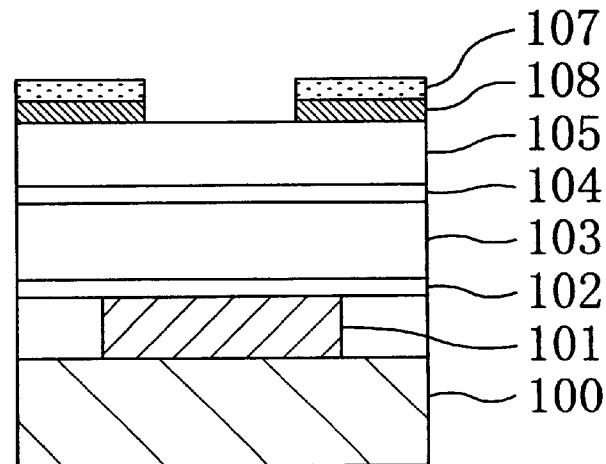


Fig. 4(c)



# 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.