United States Patent [19]

Ngan et al.

[11] Patent Number: 5,882,399

[45] Date of Patent: Mar. 16, 1999

[54] **METHOD OF FORMING A BARRIER LAYER WHICH ENABLES A CONSISTENTLY HIGHLY ORIENTED CRYSTALLINE STRUCTURE IN A METALLIC INTERCONNECT**

[75] Inventors: **Kenny King-tai Ngan**, Fremont; **Barry Hogan**, Santa Clara; **Seshadri Ramaswami**, San Jose, all of Calif.

[73] Assignee: **Applied Materials, Inc.**, Santa Clara, Calif.

[21] Appl. No.: **924,487**

[22] Filed: **Aug. 23, 1997**

[51] **Int. Cl.^{6}** **C30B 6/00**

[52] **U.S. Cl.** **117/89**; 117/939; 117/949; 117/103; 438/648

[58] **Field of Search** 438/648, 652, 438/656, 622, 373, 766; 117/89, 92, 939, 949, 103, 105

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,514,437	4/1985	Nath	427/39
4,911,894	3/1990	Retallick et al.	422/174
4,944,961	7/1990	Lu et al.	427/38
4,990,229	2/1991	Campbell et al.	204/298.06
5,108,951	4/1992	Chen et al.	437/187
5,141,897	8/1992	Manocha et al.	437/228
5,186,718	2/1993	Tepman et al.	29/25.01
5,236,868	8/1993	Nulman	437/190
5,262,361	11/1993	Cho et al.	437/245
5,288,665	2/1994	Nulman	437/194
5,320,728	6/1994	Tepman	204/192.12
5,346,600	9/1994	Nieh et al.	204/192.3
5,360,524	11/1994	Hendel et al.	204/192.25
5,364,664	11/1994	Tsubouchi et al.	427/535
5,371,042	12/1994	Ong	437/194
5,374,592	12/1994	MacNaughton et al.	437/194
5,391,517	2/1995	Gelatos	437/190
5,420,072	5/1995	Fiordalice	437/192
5,464,666	11/1995	Fine et al.	427/576
5,472,912	12/1995	Miller	437/194
5,497,025	3/1996	Wong	257/435
5,521,120	5/1996	Nulman	437/190
5,523,259	6/1996	Merchant	437/190
5,525,837	6/1996	Choudhury	257/751
5,526,951	6/1996	Bailey et al.	216/24
5,543,357	8/1996	Yamada et al.	437/192
5,571,752	11/1996	Chen et al.	437/189
5,627,102	5/1997	Shinriki	437/192
5,670,420	9/1997	Choi	437/189

OTHER PUBLICATIONS

"Tin formed by evaporation as a diffusion barrier between Al and Si" (J. Vac. Sci Technol. 21 (1) May/Jun. 1982) Ting pp. 14–17.

Primary Examiner—R. Bruce Breneman
Assistant Examiner—Shamim Ahmed
Attorney, Agent, or Firm—Shirley L. Church
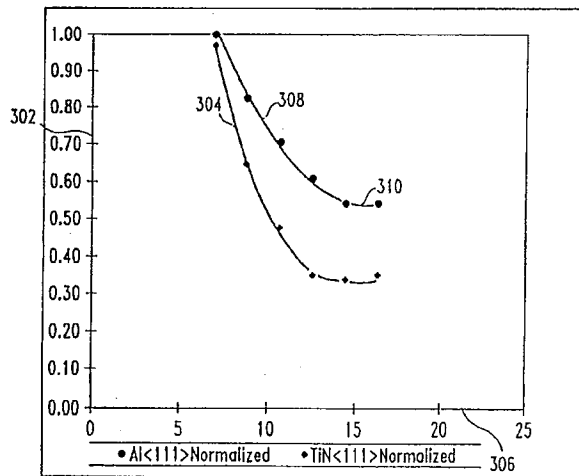
[57] **ABSTRACT**

The aluminum <111> crystal orientation content of an aluminum interconnect layer or the copper <111> crystal orientation content of a copper interconnect can be maintained at a consistently high value during the processing of an entire series of semiconductor substrates in a given process chamber. To provide the stable and consistent aluminum <111> content, or the stable and consistent copper <111> content, it is necessary that the barrier layer structure underlying the aluminum or the copper have a consistent crystal orientation throughout the processing of the entire series of substrates, as well. We have determined that to ensure the consistent crystal orientation content of the barrier layer structure, it is necessary to form the first layer of the barrier layer structure to have a minimal thickness of at least about 150 Å, to compensate for irregularities in the crystal orientation which may by present during the initial deposition of this layer. As an alternative to increasing the thickness of the first layer of the barrier layer structure, this first layer can be deposited a low process chamber pressure, so that harmful irregularities in the crystal orientation are eliminated.
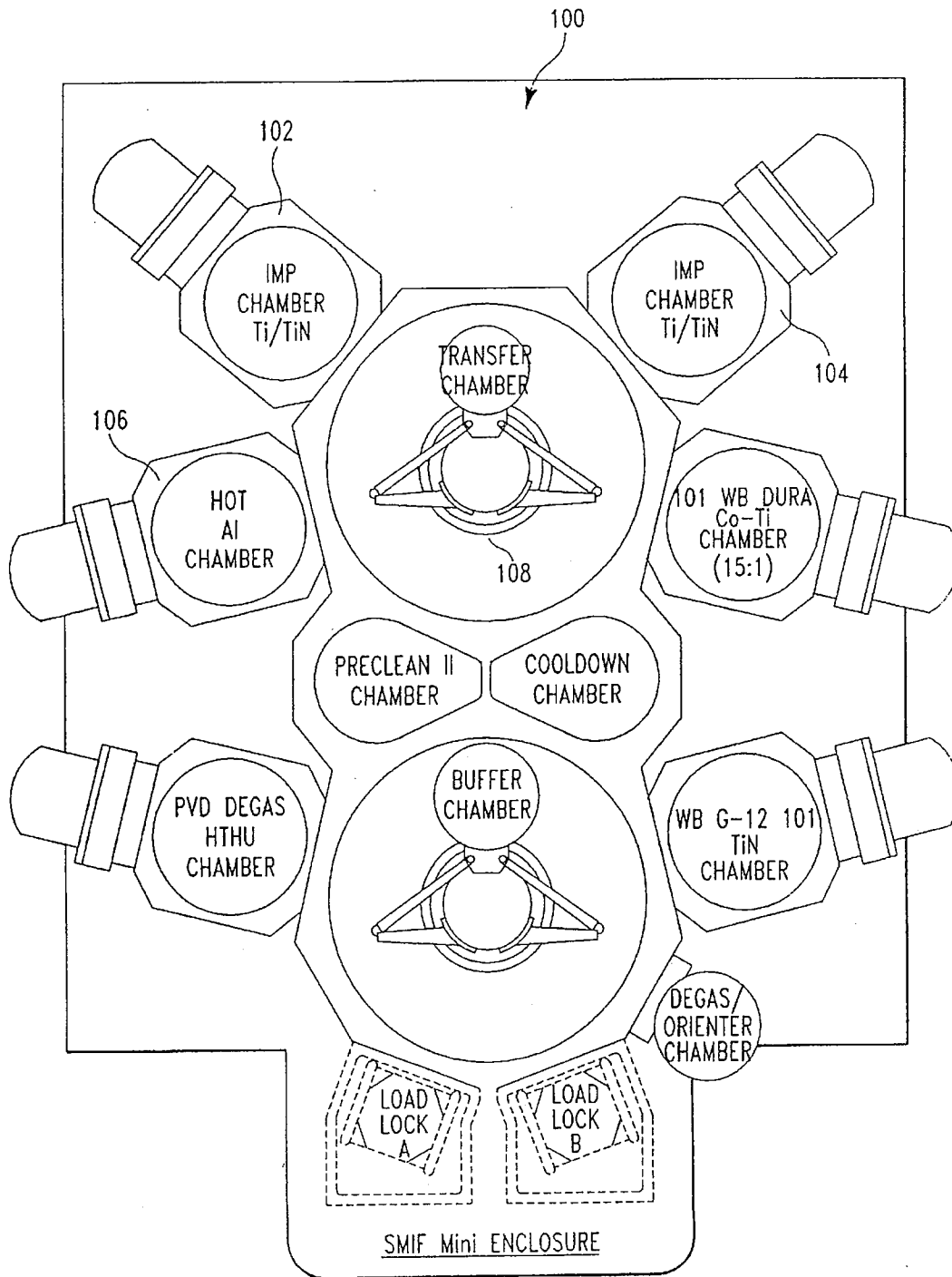
30 Claims, 4 Drawing Sheets

100

102

IMP
CHAMBER
Ti/TiN

IMP
CHAMBER
Ti/TiN

104

TRANSFER
CHAMBER

106

HOT
Al
CHAMBER

101 WB DURA
Co-Ti
CHAMBER
(15:1)

108

PRECLEAN II
CHAMBER

COOLDOWN
CHAMBER

PVD DEGAS
HTHU
CHAMBER

BUFFER
CHAMBER

WB G-12 101
TiN
CHAMBER

DEGAS/
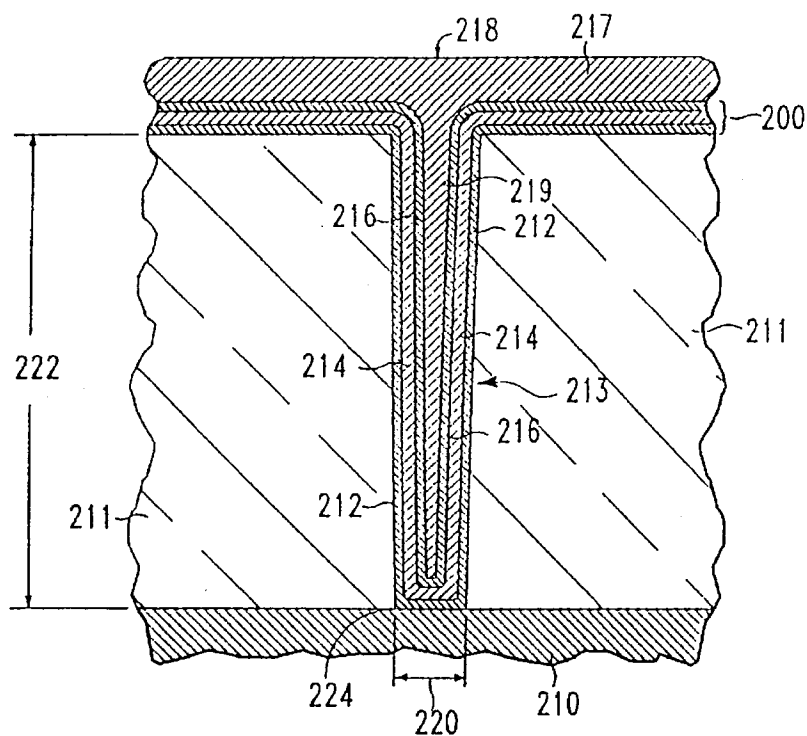ORIENTER
CHAMBER

LOAD
LOCK
A

LOAD
LOCK
B

SMIF Mini ENCLOSURE

(PRIOR ART)
FIG. 1

FIG. 2 (PRIOR ART)

FIG. 3

FIG. 4

FIG. 5

IMP Ti Film Crystal Orientation

FIG. 6

DOCKET ALARM
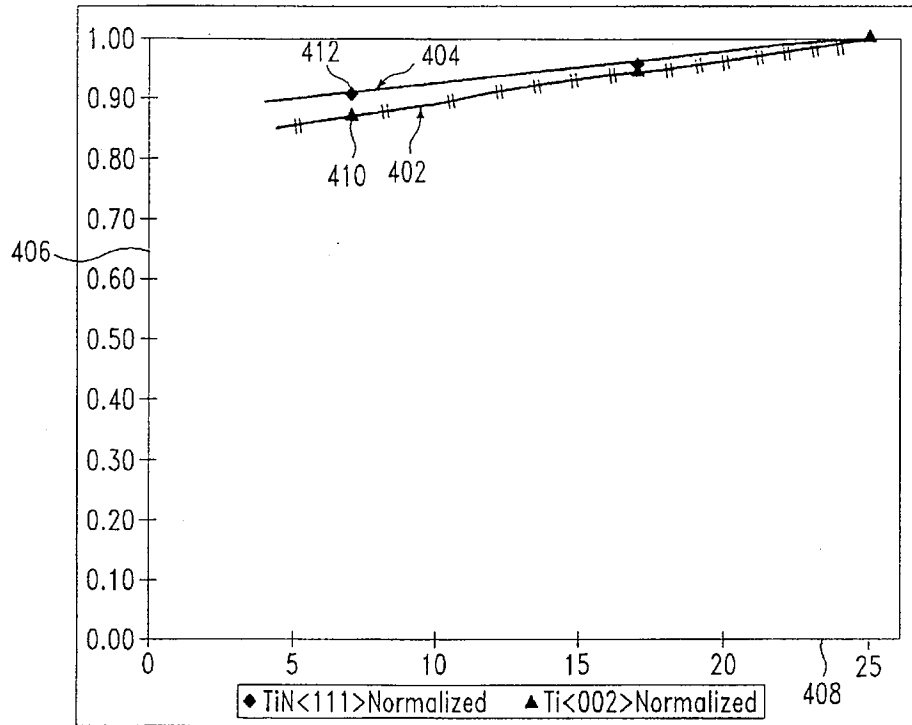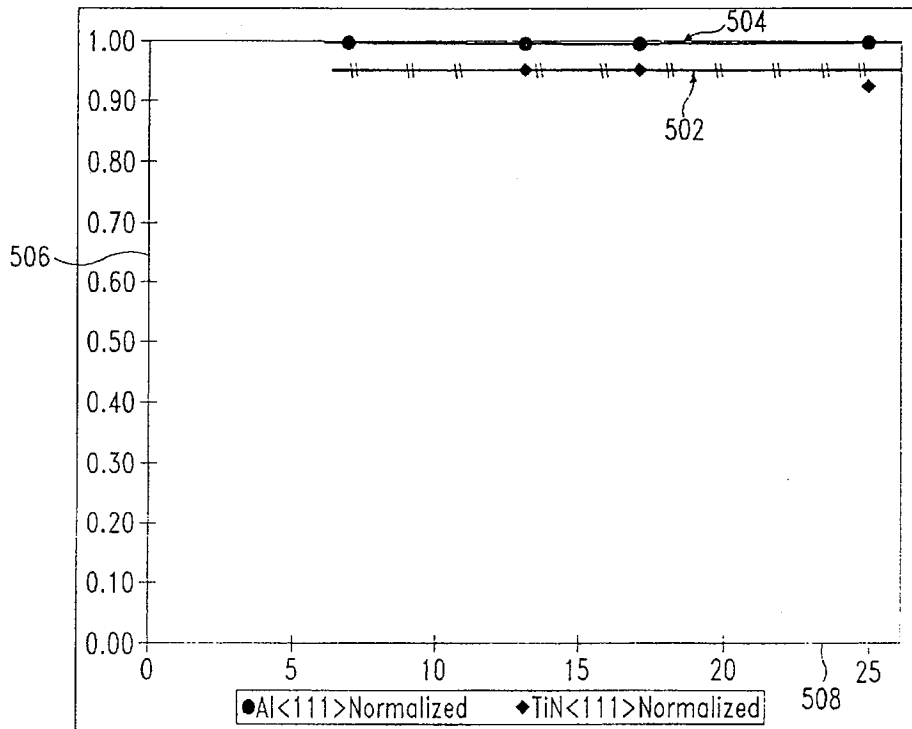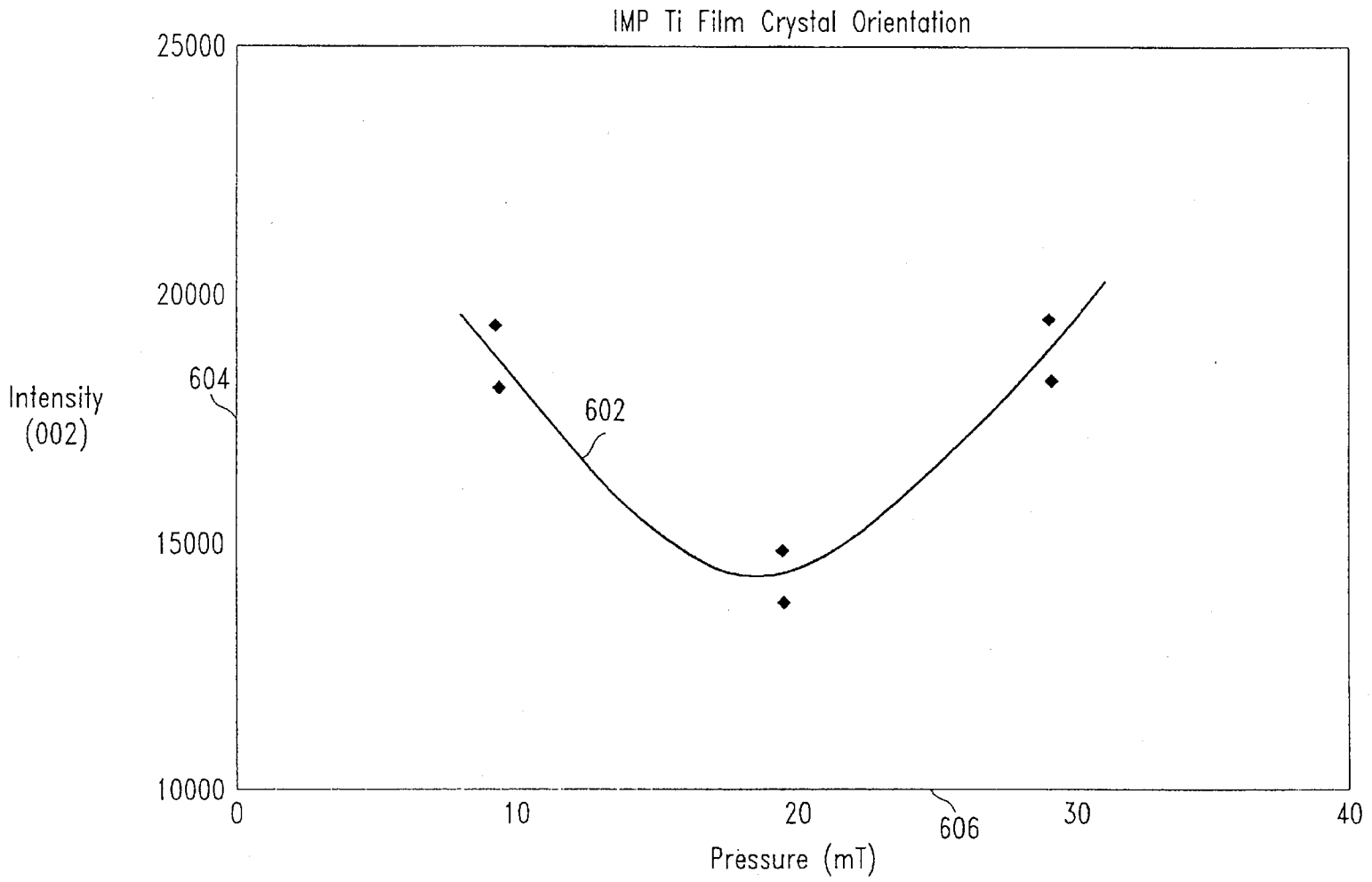
Explore Litigation Insights

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.

fastcase
Smarter legal research.