
EXHIBIT A

(12) **United States Patent**
Tagami et al.(10) **Patent No.:** **US 6,538,324 B1**
(45) **Date of Patent:** **Mar. 25, 2003**(54) **MULTI-LAYERED WIRING LAYER AND METHOD OF FABRICATING THE SAME**(75) Inventors: **Masayoshi Tagami**, Tokyo (JP);
Yoshihiro Hayashi, Tokyo (JP)(73) Assignee: **NEC Corporation**, Tokyo (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.: **09/596,415**(22) Filed: **Jun. 19, 2000**(30) **Foreign Application Priority Data**

Jun. 24, 1999 (JP) 11-214110

(51) **Int. Cl.⁷** **H01L 23/48; H01L 23/52**(52) **U.S. Cl.** **257/751; 257/762**(58) **Field of Search** **257/751, 752, 257/753, 758, 762, 773; 438/626, 627, 628, 643, 644, 645**(56) **References Cited****U.S. PATENT DOCUMENTS**5,668,411 A * 9/1997 Hong et al. 257/751
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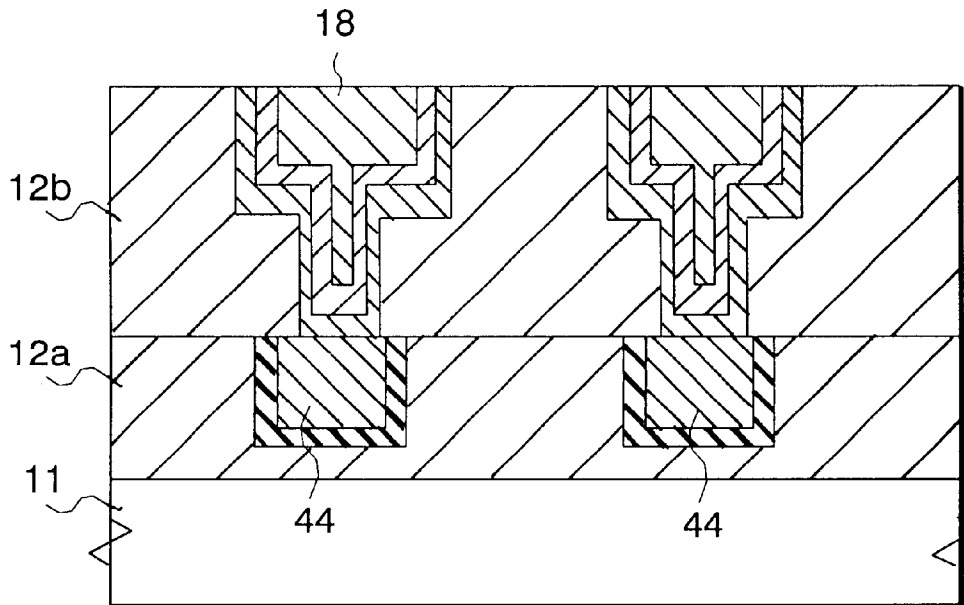
M. T. Wang, et al., "Barrier Properties of Very Thin Ta and TaN Layers Against Copper Diffusion", Journal Electrochemical Society, Jul. 1998, pp. 2538-2545.

D. Denning, et al., An Inlaid CVD Cu Based Integration for Sub 0.25 μ m Technology, 1998 Symposium on VLSI Technology Digest of Technical Papers, 1998, pp. 22-23.

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Primary Examiner—Tom Thomas*Assistant Examiner*—Hung Kim Vu(74) *Attorney, Agent, or Firm*—Scully, Scott, Murphy & Presser(57) **ABSTRACT**

There is provided a barrier film preventing diffusion of copper from a copper wiring layer formed on a semiconductor substrate. The barrier film has a multi-layered structure of first and second films wherein the first film is composed of crystalline metal containing nitrogen therein, and the second film is composed of amorphous metal nitride. The barrier film is constituted of common metal atomic species. The barrier film prevents copper diffusion from a copper wiring layer into a semiconductor device, and has sufficient adhesion characteristic to both a copper film and an interlayer insulating film.

10 Claims, 20 Drawing Sheets

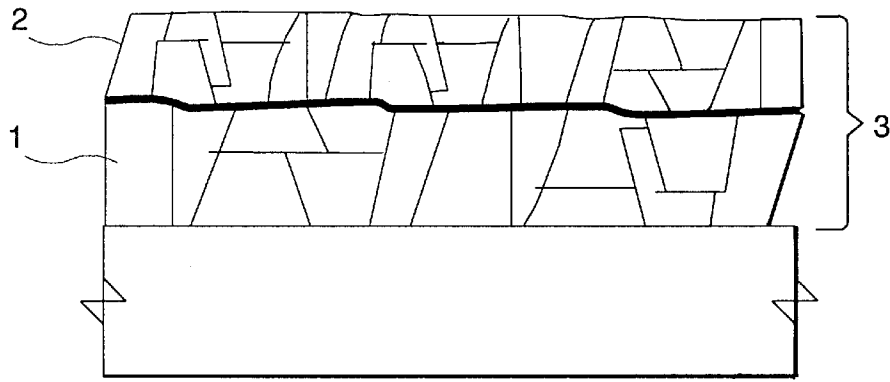


FIG. 1
(Prior Art)

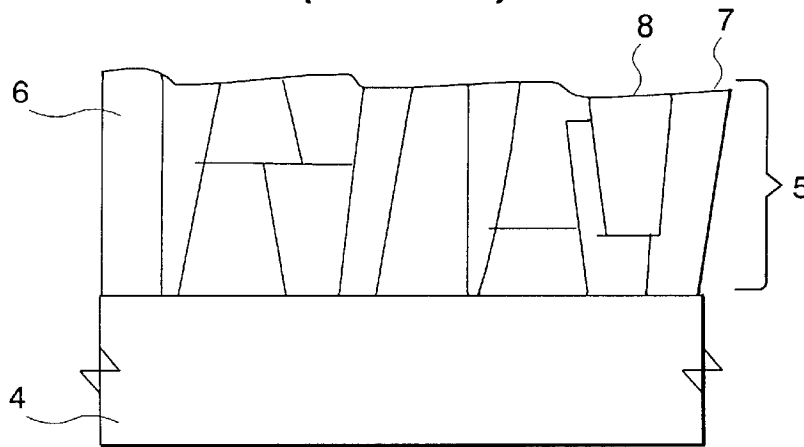


FIG. 2
(Prior Art)

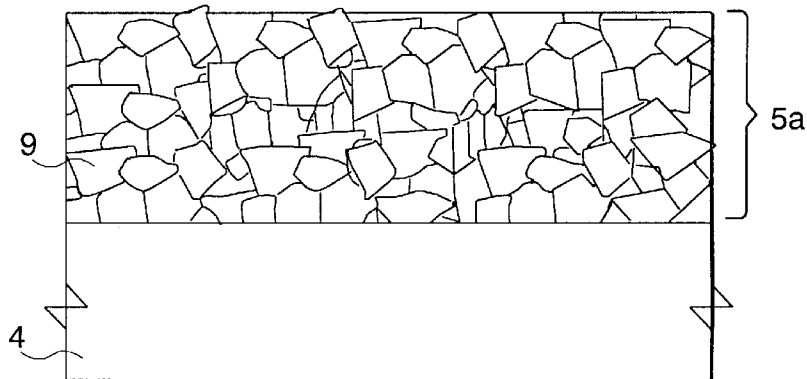


FIG. 3
(Prior Art)

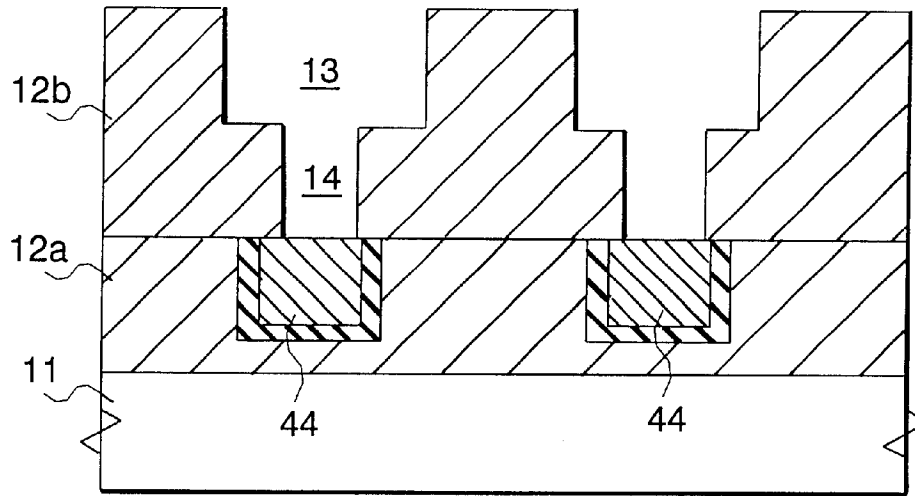


FIG. 4A

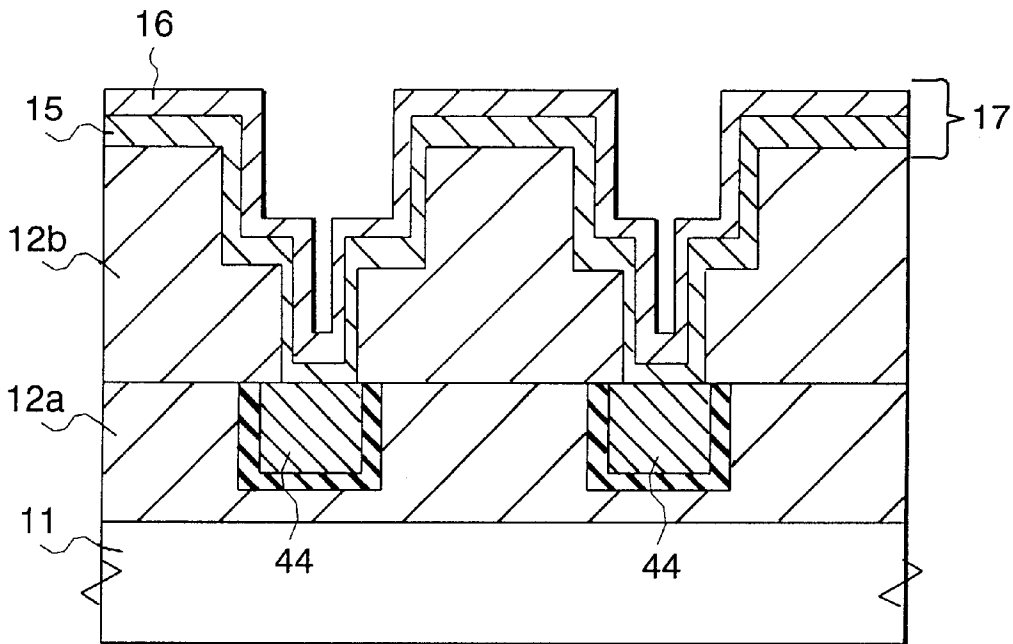


FIG. 4B

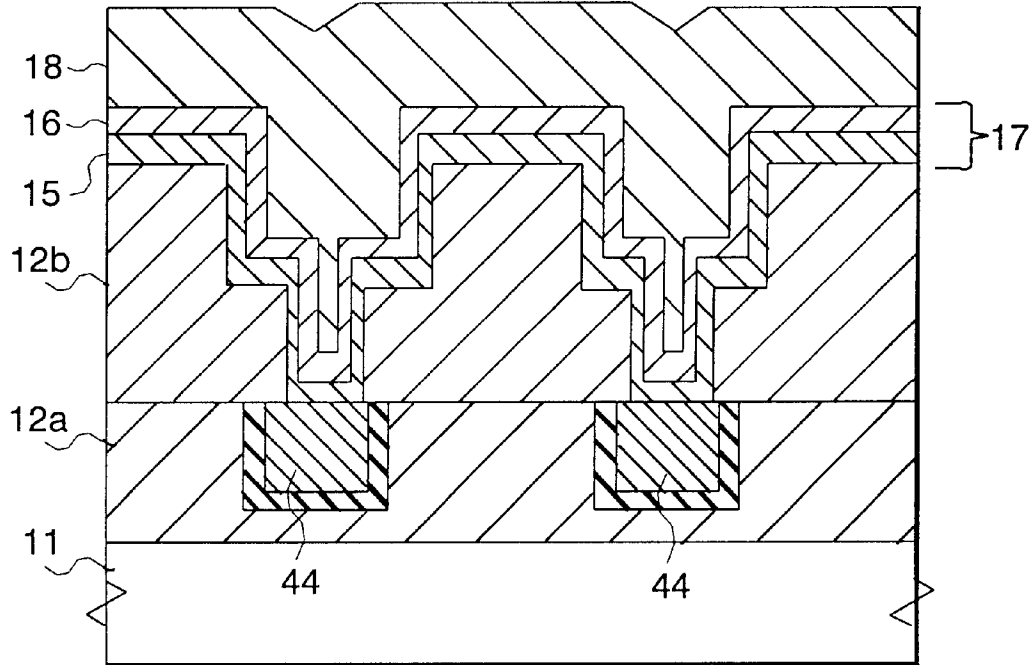


FIG. 4C

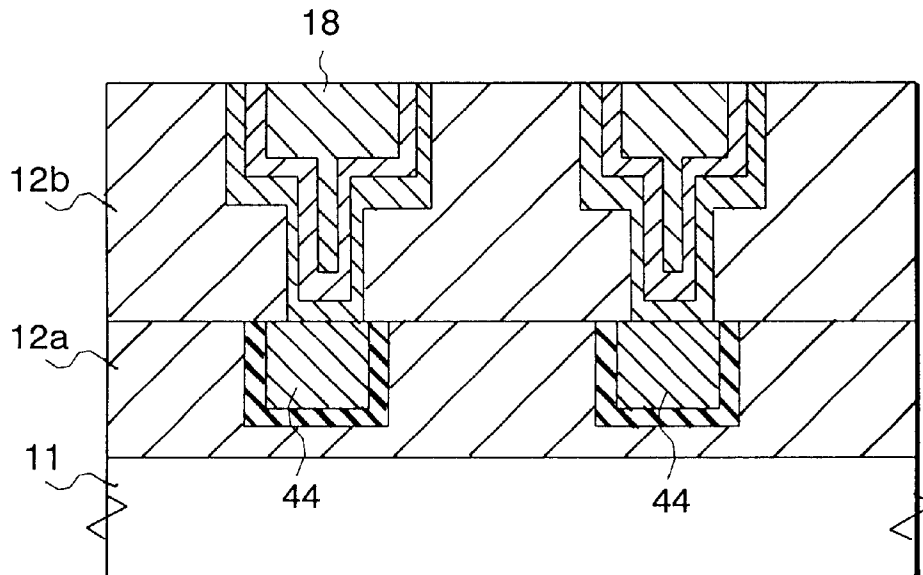


FIG. 4D

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