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United States Patent [19]

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Hogan

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[54] **BARRIER LAYER STRUCTURE WHICH PREVENTS MIGRATION OF SILICON INTO AN ADJACENT METALLIC LAYER AND THE METHOD OF FABRICATION OF THE BARRIER LAYER**

U.S. Patent Application, Serial No. 08/511,825 of Xu et al., filed Aug. 7, 1995.

U.S. Patent Application Serial No. 08/824,911 of Ngan et al., filed Mar. 27, 1997.

U.S. Patent Application Serial No. 08/825,216 of Ngan et al., filed Mar. 27, 1997.

[75] Inventor: **Barry Hogan**, Santa Clara, Calif.

Primary Examiner—Caridad Everhart
Attorney, Agent, or Firm—Kenyon & Kenyon; Shirley L. Church

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

[21] Appl. No.: **08/958,472**

[57] ABSTRACT

[22] Filed: **Oct. 27, 1997**

[51] Int. Cl.⁷ **H01L 21/461**

An improved barrier layer structure for the prevention of migration within a semiconductor device can be formed from a refractory metal compound such as a refractory metal nitride. The preferred barrier layer structure includes at least two adjacent layers of essentially the same chemical composition having an essentially continuous interfacial region between them, wherein the interfacial region is at least 10 Å thick. As an alternative to having a continuous interfacial region, a series of adjacent layers which provide sufficient interfacial regions can be used in combination to block the migration of mobile atoms such as silicon. When a series of layers is used, there should be at least 3 layers, and preferably 5 or more layers, where each layer is at least about 50 Å thick. In addition, to break the continuity of channels passing through grain boundaries, alternating layers of substantially grain oriented, columnar microstructure and amorphous, non-columnar structure are preferred. The preferred embodiment used to demonstrate the invention is a titanium nitride-comprising barrier layer structure prepared using ion metal plasma or reactive ion metal plasma deposition techniques to create the interfacial regions.

[52] U.S. Cl. **438/653; 438/685; 438/643**

[58] Field of Search **438/653, 685, 438/643, 627**

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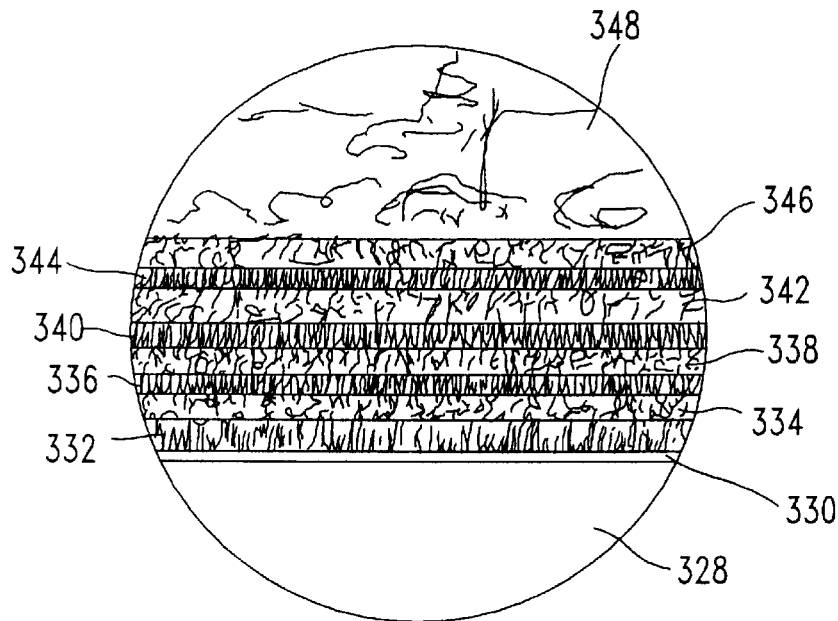
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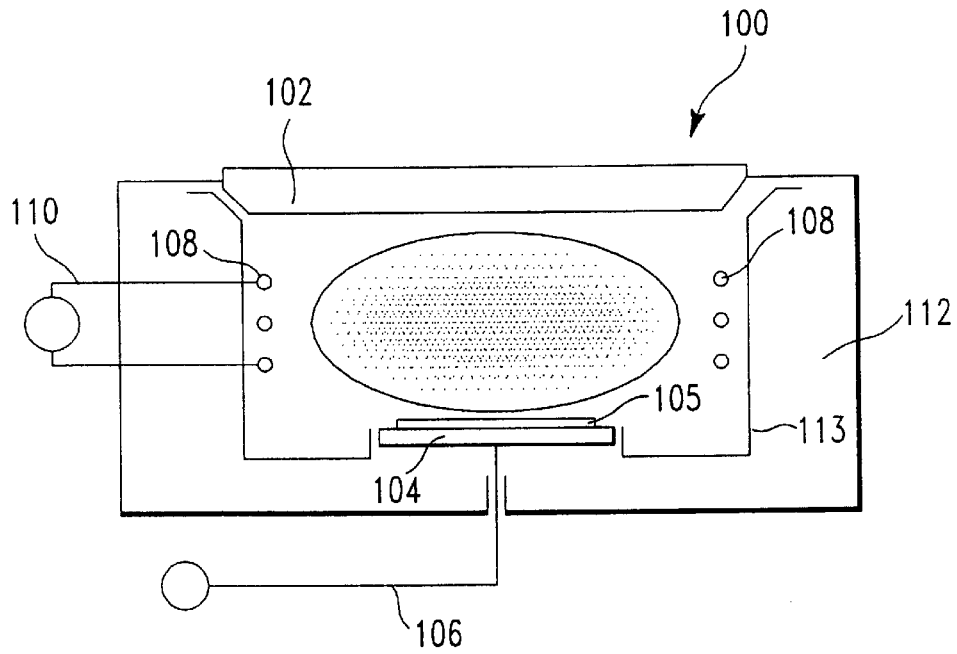
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12 Claims, 4 Drawing Sheets





PRIOR ART
FIG. 1

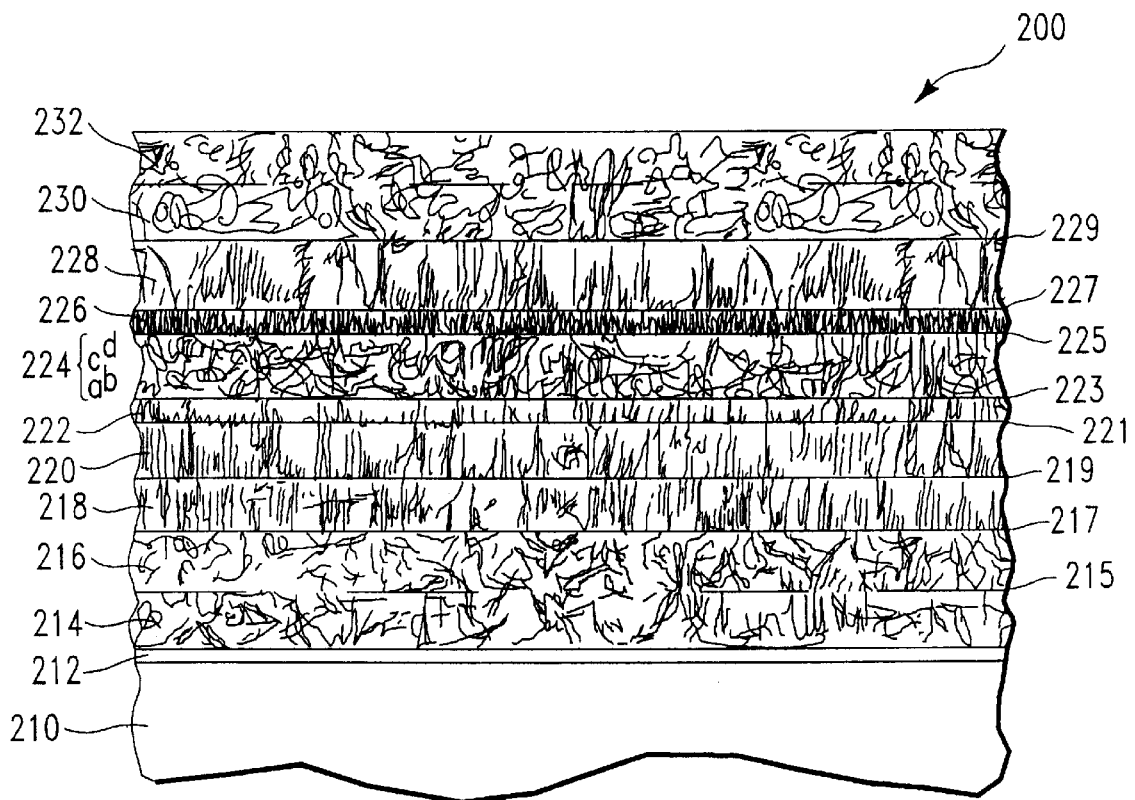


FIG. 2

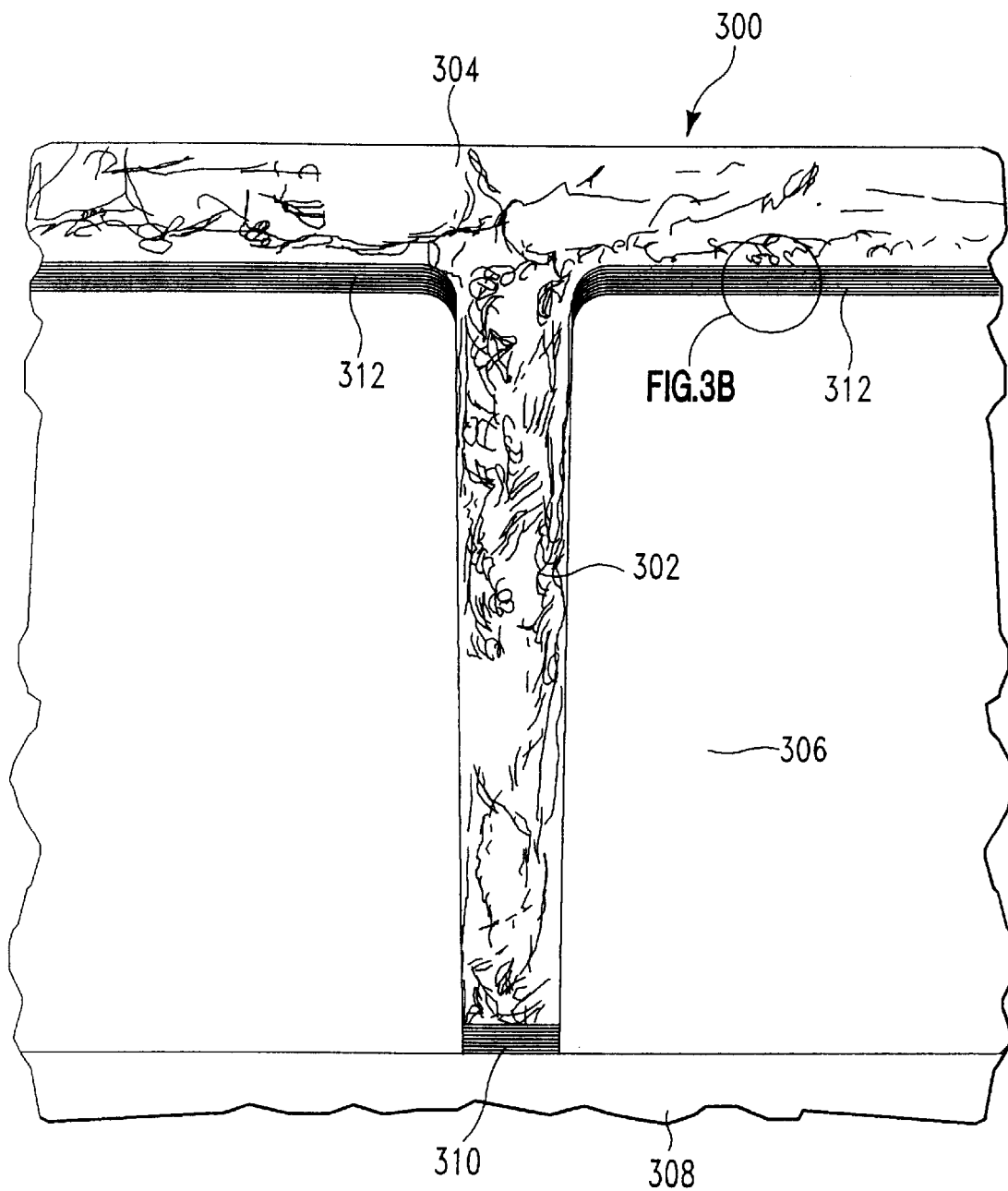


FIG. 3A

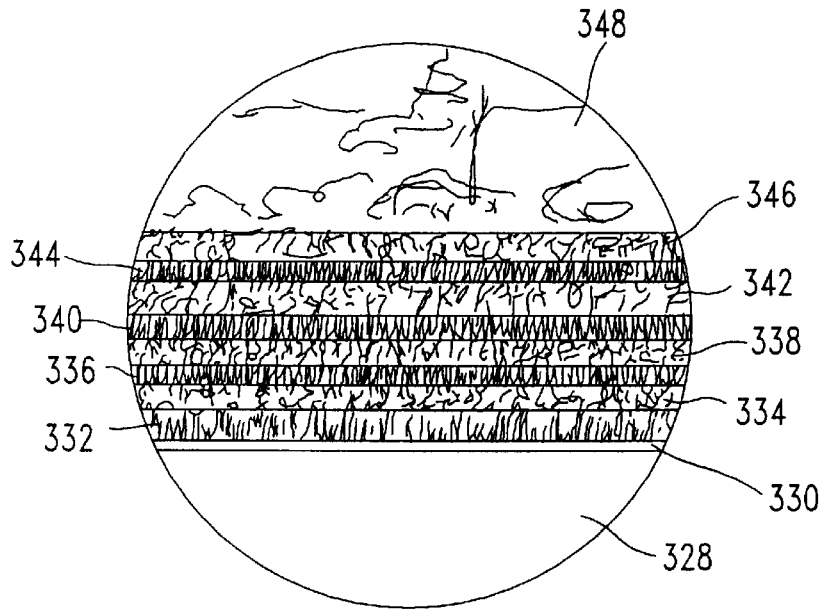


FIG. 3B

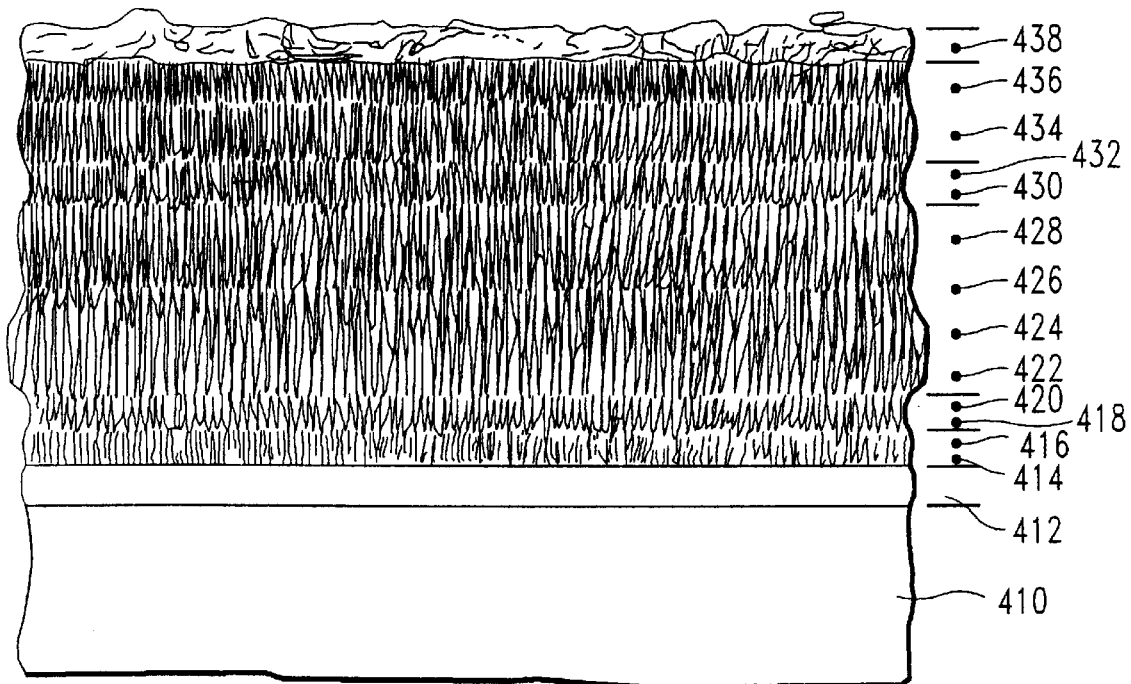


FIG. 4

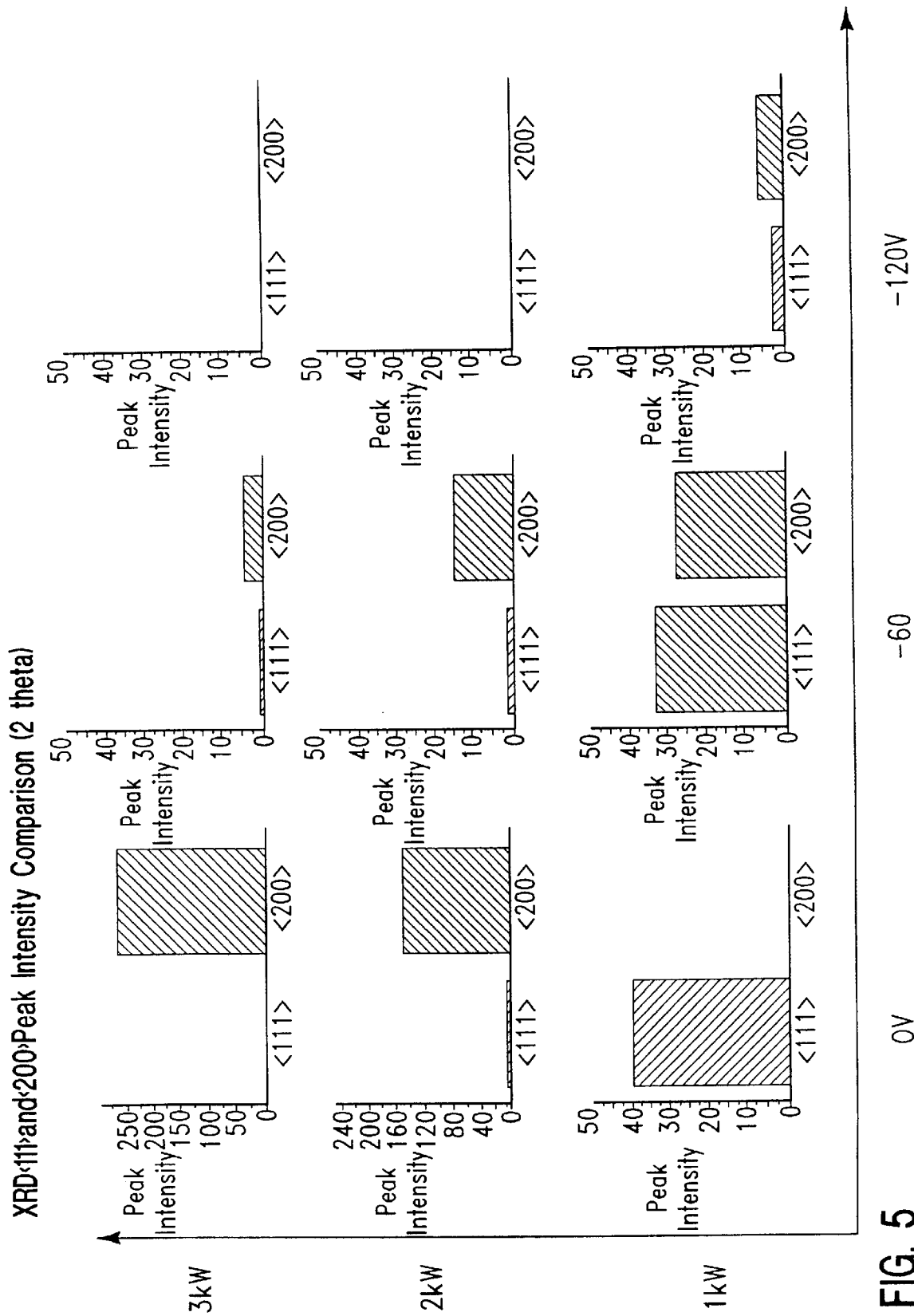


FIG. 5

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