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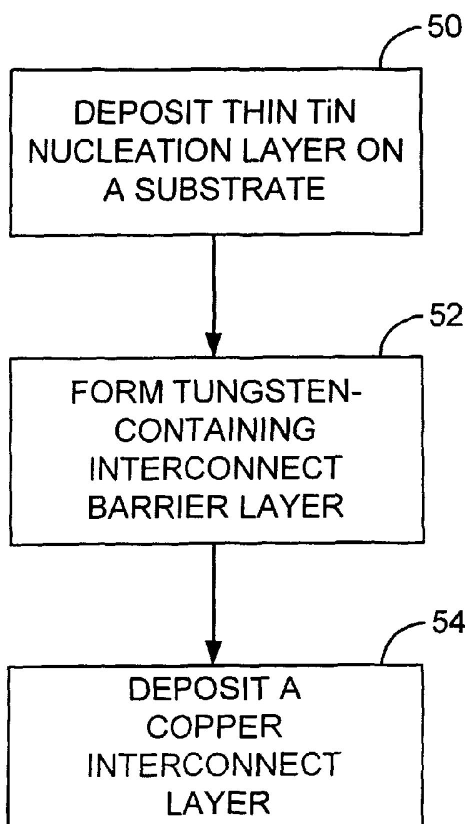
(54) Title: COPPER INTERCONNECT BARRIER LAYER STRUCTURE AND FORMATION METHOD



(57) Abstract: A method for forming a tungsten-containing copper interconnect barrier layer (e.g., a tungsten [W] or tungsten-nitride [W_xN] copper interconnect barrier layer) on a substrate with a high (e.g., greater than 30%) sidewall step coverage and ample adhesion to underlying dielectric layers. The method includes first depositing a thin titanium-nitride (TiN) or tantalum nitride (TaN) nucleation layer (12) on the substrate, followed by the formation of a tungsten-containing copper interconnect barrier layer (20) (e.g., a W orW_xN copper interconnect barrier layer) overlying the substrate. The tungsten-containing copper interconnect barrier layer can, for example, be formed using a Chemical Vapor Deposition (CVD) technique that employs a fluorine-free tungsten-containing gas (e.g., tungsten hexacarbonyl [$W(CO)_6$]) or a WF_6-based Atomic Layer Deposition (ALD) technique. The presence of a thin TiN (or TaN) nucleation layer facilitates the formation of a tungsten-containing copper interconnect barrier layer with a sidewall step coverage of greater than 30% and ample adhesion to dielectric layers. A copper interconnect barrier layer structure includes a thin titanium-nitride (TiN) (or tantalum nitride [TAN]) nucleation layer disposed directly on the dielectric substrate (e.g., a single or dual-damascene copper interconnect dielectric substrate). The copper interconnect barrier layer structure also includes a tungsten-containing copper interconnect barrier layer (e.g., a W or W_xN copper interconnect barrier layer) formed on the thin TiN (or TaN) nucleation layer using, for example, a CVD technique that employs a fluorine-free tungsten-containing gas (e.g., [$W(CO)_6$]) or a WF_6-based ALD technique.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01L21/768

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 6 258 707 B1 (UZOH CYPRIAN E) 10 July 2001 (2001-07-10) column 8, line 9 -column 9, line 23; figure 12 ---	1,2, 8-12, 18-20, 32,33
Y	WO 01 29891 A (ASM INC) 26 April 2001 (2001-04-26) the whole document ---	1,3-6, 13-15, 18-22, 35-37
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

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