

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
21 December 2007 (21.12.2007)

PCT

(10) International Publication Number
WO 2007/147020 A3

(51) International Patent Classification:
C23C 16/00 (2006.01) C23C 16/02 (2006.01)

(74) Agent: HULTQUIST, Steven, J.; Intellectual Prop-
erty/technology Law, P.O. Box 14329, Research Triangle
Park, NC 27709 (US).

(21) International Application Number:
PCT/US2007/071153

(22) International Filing Date: 13 June 2007 (13.06.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/813,968 15 June 2006 (15.06.2006) US

(71) Applicant (for all designated States except US): AD-
VANCED TECHNOLOGY MATERIALS, INC.
[US/US]; 7 Commerce Drive, Danbury, CT 06810-4169
(US).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH,
CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG,
ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL,
IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK,
LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW,
MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL,
PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY,
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA,
ZM, ZW.

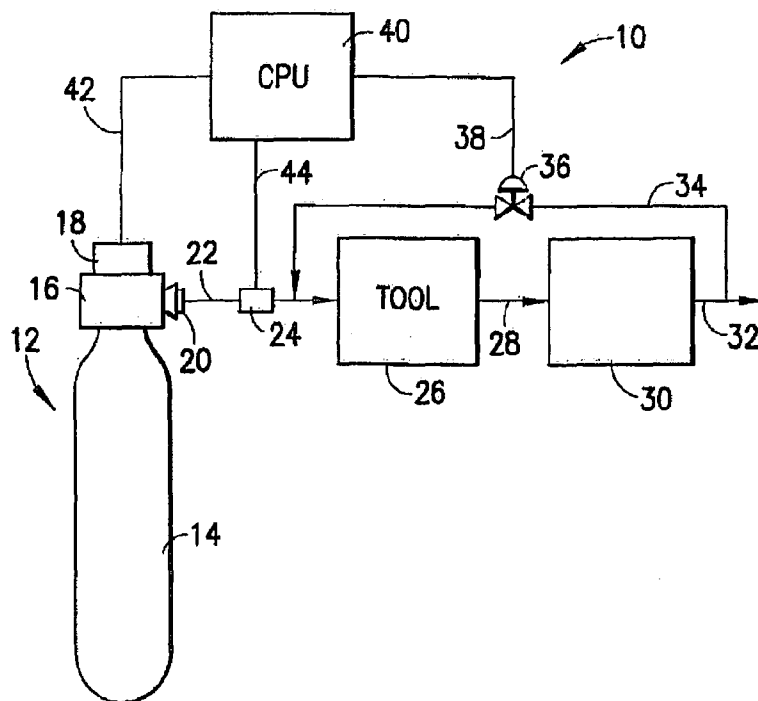
(72) Inventors; and

(75) Inventors/Applicants (for US only): CHEN, Tianniu
[CN/US]; 146 Sunset Ridge, Rocky Hill, CT 06067 (US).
XU, Chongying [US/US]; 8 Heather Court, New Milford,
CT 06776 (US). ROEDER, Jeffrey, F. [US/US]; 4 Long-
meadow Hill Road, Brookfield, CT 06804 (US). BAUM,
Thomas, H. [US/US]; 2 Handol Lane, New Fairfield,
CT 06812 (US). HENDRIX, Bryan, C. [US/US]; 42
Kingswood Road, Danbury, CT 06811 (US).

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL,
PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM,
GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: COBALT PRECURSORS USEFUL FOR FORMING COBALT-CONTAINING FILMS ON SUBSTRATES



(57) Abstract: Cobalt precursors for forming metallic cobalt thin films in the manufacture of semiconductor devices, and methods of depositing the cobalt precursors on substrates, e.g., using chemical vapor deposition or atomic layer deposition processes. Packaged cobalt precursor compositions, and microelectronic device manufacturing systems are also described.

WO 2007/147020 A3



Published:

- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) Date of publication of the international search report:
2 May 2008

INTERNATIONAL SEARCH REPORT

07/07/1155 08-08-2008
International application No.

PCT/US 07/71153

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - C23C 16/00, C23C 16/02 (2008.01)

USPC - 427/252, 427/299

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(8): C23C 16/00, C23C 16/02 (2008.01)

USPC: 427/252, 427/299

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 427/569, 428/446, 556/9 (Keywords limited - See list for keywords)

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

PubWEST (USPT,PGPB,EPAB,JPAB); DialogPRO(Chemistry); Google Scholar

Search Terms: cobalt, CVD, amidinate, guanidinate, isoureate, adhesion, adhesive, ALD, carbodiimide, solvent, organic, alkyl, aryl, amine, deposited, thickness, circuit, integrated, precursor, substrate, reactant, microelectronic, silanes, amides, carbon

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/0035462 A1 (Millward) 16 February 2006 (16.02.2006), entire document, especially, para [0001], [0007], [0008], [0010], [0012], [0017], [0019], [0022]-[0024], [0026], [0028]-[0030], [0032], [0035], [0036], [0038], [0041]-[0044], [0050], [0054], [0056], [0063] and [0068]	22-27, 29-40, 43, 45-47, 49, 50
Y		1(a), 1(b), 1(i), 2-3, 10, 18 -21, 28, 41, 42, 44, 48, 51 -60
Y	US 2003/0135061 A1 (Norman) 17 July 2003 (17.07.2003), entire document, especially, para [0012], [0030] and [0039]	1(a), 1(b), 1(i), 2-3, 10, 18 -21, 51-60
Y	US 2002/0197402 A1 (Chiang) 26 December 2002 (26.12.2002), entire document, especially, para [0049], [0052], [0055] and [0056]	28, 41, 42
Y	US 2001/0002323 A1 (Kobayashhi) 31 May 2001 (31.05.2001), entire document, especially, para [0023]	44, 48
Y	US 2003/0136265 A1 (Holst) 24 July 2003 (24.07.2003), entire document, especially, para [0044]	55
Y	US 2001/0045187 A1 (Uhlenbrock) 29 November 2001 (29.11.2001), entire document, especially, para [0036]	56, 57
Y	US 2006/0035014 A1 (DeYoung) 16 February 2006 (16.02.2006), entire document, especially, para [0066]	58-60

 Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

05 January 2008 (05.01.2008)

Date of mailing of the international search report

03 MAR 2008

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

Continuation of Box No. III -- Observations where unity of invention is lacking

This application contains claims directed to more than one species of the generic invention. These species are deemed to lack unity of invention because they are not so linked as to form a single general inventive concept under PCT Rule 13.1.

In order for more than one species to be examined, the appropriate additional examination fees must be paid. The species are as follows:

- Group 1: cobalt precursor is an amidate or guanidate or isoureate
- Group 2: cobalt precursor is a carbamate or thiocarbamate
- Group 3: cobalt precursor is a beta-diketonate or diketoiminate, or ditetiiminate
- Group 4: cobalt precursor is an allyl
- Group 5: cobalt precursor is a cyclopentadienyl
- Group 6: cobalt precursor is an alkyls, alkoxides and silyls with pendent ligands
- Group 7: cobalt precursor is a silylamides(cyclic) and chelate amides
- Group 8: cobalt precursor is a cobalt borohydride
- Group 9: structures a-d and g
- Group 10: structures e-f
- Group 11: structures f and h-j

The claims are deemed to correspond to the species listed above in the following manner:

- Group 1: 1(a), 1(b), 1(i), 2-3, 10, 18-60
- Group 2: 1c, 4, 18-60
- Group 3: 1d, 5, 18-60
- Group 4: 1e, 6,
- Group 5: 1f, 1k, 1l, 18-60 1m, 7, 12-14, 16, 17, 18-60.
- Group 6: 1g, 8, 18-60
- Group 7: 1h, 9, 18-60
- Group 8: 1j, 1l, 11, 12, 14-17, 18-60
- Group 9: 61a-d, g; 64a-d, g; 68a-d, g; 65-67, 69-108
- Group 10: 61e-f, 64e-f, 68e-f; 62-63, 65-67, 69-108
- Group 11: 61f, h-j; 64f, h-j; 68f, h-j; 65-67, 69-108

The species listed above do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, the species lack the same or corresponding special technical features for the following reasons:

Group 1 is directed to cobalt precursor composition comprising a cobalt precursor consisting of an amidate or guanidate or isoureate of the formulas disclosed in claim 1(a), 1(b), and 1(i).

Group 2 is directed to cobalt precursor composition comprising a cobalt precursor consisting of a carbamate or thiocarbamate of the formula disclosed in claim 1(c).

Group 3 is directed to cobalt precursor composition comprising a cobalt precursor consisting of a beta-diketonate or diketoiminate, or ditetiiminate of the formula disclosed in claim 1(d).

Group 4 is directed to cobalt precursor composition comprising a cobalt precursor consisting of an allyl of the formula disclosed in claim 1(e).

Group 5 is directed to cobalt precursor composition comprising a cobalt precursor comprising a cyclopentadienyl of the formulas disclosed in claim 1(f), 1(k), 1(l), and 1(m).

Group 6 is directed to cobalt precursor composition comprising a cobalt precursor consisting of an alkyls, alkoxides and silyls with pendent ligands of the formula disclosed in claim 1(g).

Group 7 is directed to cobalt precursor composition comprising a cobalt precursor consisting of a silylamides(cyclic) and chelate amides of the formula disclosed in claim 1(h).

Group 8 is directed to cobalt precursor composition comprising a cobalt precursor consisting of a cobalt borohydride of the formula disclosed in claim 1(j) and 1(l).

Group 9 is directed to cobalt precursor composition of the structures a-d and g of claims 61, 64, and 68.

Group 10 is directed to cobalt precursor composition of the structures e-f of claims 61, 64, and 68.

Group 11 is directed to cobalt precursor composition of the structures f and h-j of claims 61, 64, and 68.

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

-- see extra sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1(a), 1(b), 1(i), 2-3, 10, 18-60

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.