



- (51) **International Patent Classification:**
C30B 1/02 (2006.01) *C30B 25/18* (2006.01)
- (21) **International Application Number:**
PCT/US2014/033157
- (22) **International Filing Date:**
7 April 2014 (07.04.2014)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
61/813,554 18 April 2013 (18.04.2013) US
61/880,416 20 September 2013 (20.09.2013) US
- (71) **Applicant:** DREXEL UNIVERSITY [US/US]; 3141 Chestnut Street, Philadelphia, PA 19104 (US).
- (72) **Inventors:** SPANIER, Jonathan, E.; 43 Llanberris Road, Bala Cynwyd, PA 19004 (US). AKBASHEU, Andrei; 2215 Arch Street, Apt. 211, Philadelphia, PA 19103 (US).
- (74) **Agents:** CALDWELL, John, W. et al.; Baker & Hostetler LLP, Cira Centre, 12th Floor, 2929 Arch Street, Philadelphia, PA 19104 (US).
- (81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, 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, IR, IS, JP, KE, KG, 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, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

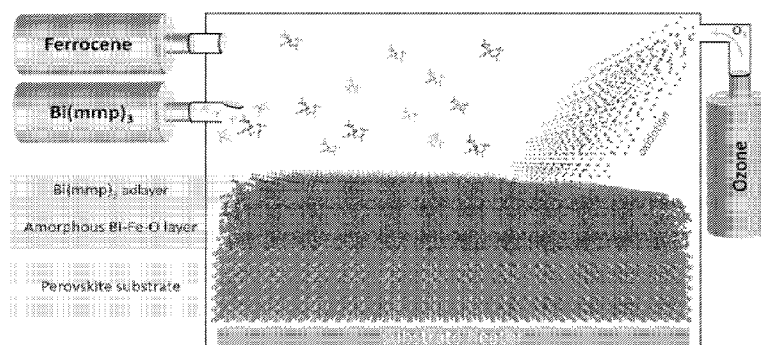
— with international search report (Art. 21(3))

- (88)
- Date of publication of the international search report:**

10 December 2015

(54) **Title:** METHODS OF FORMING PEROVSKITE FILMS

FIG. 1



(57) **Abstract:** This disclosure provides methods for forming a perovskite film. Exemplary methods can include the steps of forming an amorphous layer on a substrate disposed in a reaction chamber, covering at least a portion of the amorphous layer with a barrier that at least partially prevents the first metal, the second metal, oxygen atoms, or a combination thereof from being released during annealing and annealing the amorphous layer to form a perovskite film. Formation of the amorphous layer on the substrate disposed in a reaction chamber may be effected by introducing a first compound comprising a first metal; introducing an oxidizing agent; and introducing a second compound comprising a second metal.

INTERNATIONAL SEARCH REPORT

4014/US33157-25.08.2014

International application No.

PCT/US14/33157

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - C30B 1/02, 25/18 (2014.01)

USPC - 428/697; 117/7; 427/126.3

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): C30B 1/02, 25/18 (2014.01)

USPC: 428/697; 117/7; 427/126.3

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 practicable, search terms used)

MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); Google Scholar; ProQuest; IP.com; atomic layer deposition, metal source, precursor, oxidize, ozone, cover, anneal, substrate, perovskite, epitaxial, layer, film

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 7,713,584 B2 (HATANPAA, T et al.) 11 May 2010; figure 2; column 1, lines 49-67; column 2, lines 1-26; column 4, lines 16-38; column 7, lines 32-67; column 8, lines 1-67; column 9, lines 1-38; column 10, lines 13-31; claims 1, 9, 25	1-18, 20, 22-24, 26-28 --- 19, 21, 25, 29-30
Y	US 7,170,095 B2 (VAUDO, RP et al.) 30 January 2007; column 8, lines 42-59	19
Y	US 5,114,906 A (HIGAKI, K et al.) 19 May 1992; column 2, lines 13-21	21
Y	US 5,556,463 A (GUENZER, CS) 17 September 1996; abstract	25
Y	ANNEALSYS Rapid Thermal Processing furnaces & Chemical Vapor Deposition systems" 28 February 2011. [online], [retrieved on 2014-07-21]. Retrieved from the Internet <URL: https://web.archive.org/web/20110228051708/http://www.annealsys.com/annealsys-products/rtp-rtcvd >; page 1	29
Y	US 5,437,761 A (KOIDE, A) 01 August 1995; column 3, lines 6-9	30
A	Simoes, A et al. Lanthanum-doped Bi4Ti3O12 prepared by the soft chemical method: Rietveld analysis and piezoelectric properties. Ceramics International, 2008. Vol. 34; entire document	1-30
A	Hanada, A et al. Developmental mechanism for the resistance change effect in perovskite oxide-based resistive random access memory consisting of Bi2Sr2CaCu2O8+d bulk single crystal. Journal of Applied Physics. Vol. 110.8. 2011; entire document	1-30



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

29 July 2014 (29.07.2014)

Date of mailing of the international search report

25 AUG 2014

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:

Shane Thomas

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

~~US 2014/033157 A1~~ 25.08.2014

International application No.

PCT/US14/33157

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Izuha, M et al. Electrical properties of all-perovskite oxide (SrRuO ₃ /Ba _x Sr _{1-x} TiO ₃ /SrRuO ₃) capacitors. Japanese Journal of Applied Physics. Vol. 36.9S. 1997; entire document	1-30
A/P	US 2014/0191618 A1 (KIJIMA, T et al.) 10 July 2014; abstract	30