



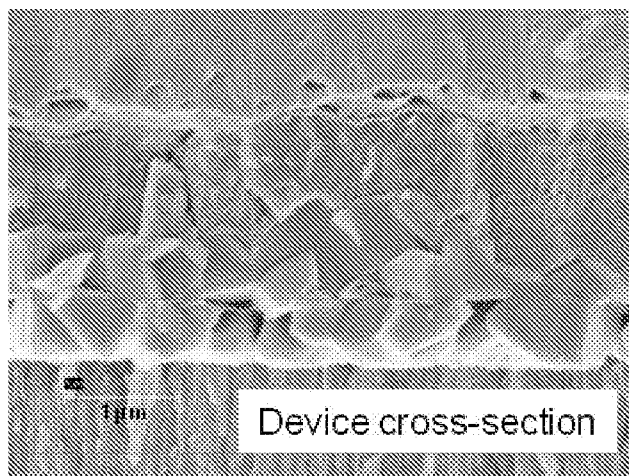
- (51) International Patent Classification:
H01L 31/042 (2006.01) *H01L 31/18* (2006.01)
- (21) International Application Number:
PCT/US201 1/051817
- (22) International Filing Date:
15 September 201 1 (15.09.201 1)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/383,292 15 September 2010 (15.09.2010) US
61/439,735 4 February 201 1 (04.02.201 1) US
61/498,383 17 June 201 1 (17.06.201 1) US
- (71) Applicant (*for all designated States except US*): **PRE-CURSOR ENERGETICS, INC.** [US/US]; Precursor Energetics, Inc., 322 1 Scott Blvd, Santa Clara, CA 95054 (US).

- (72) Inventors; and
- (75) Inventors/Applicants (*for US only*): **FUJDALA, Kyle, L.** [US/US]; Kyle L. Furdala, 1493 Geysar Drive, San Jose, CA 95 13 1 (US). **ZHU, Zhongliang** [CN/US]; Zhongliang Zhu, 4059 Ezie Street, San Jose, CA 951 11 (US). **PAD-OWITZ, David** [US/US]; David Padowitz, 200 Central Avenue, Mountain View, CA 94043 (US). **MARKOFF JOHNSON, Paul, R.** [US/US]; Paul R. Markoff Johnson, 125 Connemara Way No. 78, Sunnyvale, CA 94087 (US). **CHOMITZ, Wayne, A.** [US/US]; Wayne A. Chomitz, 1142 Princeton St. Apt B, Santa Monica, CA 90403 (US). **KUCHTA, Matthew C.** [US/US]; Matthew C. Kuchta, 485 Vallejo Street, San Francisco, CA 94133 (US).
- (74) Agents: **ECKMAN, Richard, R.** et al; Richard R. Eckman, Eckman Basu LLP, 2225 East Bayshore Road, Suite 200, Palo Alto, CA 94303 (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, BR, BW, BY, BZ,

[Continued on nextpage]

(54) Title: ANNEALING PROCESSES FOR PHOTOVOLTAICS

Fig. 15



(57) Abstract: Processes for making a solar cell by depositing various layers of components on a substrate and converting the components into a thin film photovoltaic absorber material. Processes of this disclosure can be used to control the stoichiometry of metal atoms in making a solar cell for targeting a particular concentration and providing a gradient of metal atom concentration. A selenium layer can be used in annealing a thin film photovoltaic absorber material.





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, 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, PE, PG, PH, PL, PT, QA, RO, RS, RU,
 RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TI,
 TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA,
 ZM, ZW.

**(84) Designated States (unless otherwise indicated, for every
 Mnd of regional protection available):**

ARIPO (BW, GH,
 GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG,
 ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, 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, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(H))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(Hi))*

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

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

7 June 2012

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US201 1/051817**A. CLASSIFICATION OF SUBJECT MATTER****H01L 31/042(2006.01)i, H01L 31/18(2006.01)i**

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)

H01L 31/042; C01B 19/00; H01L 31/04; H01L 31/00

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: selenium, substrate, arrange

c. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2000-058893 A (INTERNATIONAL SOLAR ELECTRIC TECHNOLOGY, INC.) 25 February 2000 See abstract, paragraph [0055] and figures 8-10.	1-20
A	US 2007-0163637 A1 (MATTHEW R. ROBINSON et al.) 19 July 2007 See paragraphs [0112]— [0132] and figures 9-11.	1-20
A	US 2007-0163639 A1 (MATTHEW R. ROBINSON et al.) 19 July 2007 See paragraphs [0113]— [0138] and figures 9-12.	1-20

 Further documents are listed in the continuation of Box C. See patent family annex.

* 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 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

16 APRIL 2012 (16.04.2012)

Date of mailing of the international search report

17 APRIL 2012 (17.04.2012)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 189 Cheongsu-ro,
Seo-gu, Daejeon 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

KIM Min Soo

Telephone No. 82-42-481-8249



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2011/051817

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2000-058893 A	25.02.2000	AT 370518 T	15.09.2007
		AT 43038 1 T	15.05.2009
		CN 1214445 CO	10.08.2005
		CN 1241804 AO	19.01.2000
		DE 69936825 D1	27.09.2007
		DE 69936825 T2	15.05.2008
		DE 69940837 D1	10.06.2009
		EP 0978882 A2	09.02.2000
		EP 0978882 A3	20.08.2003
		EP 0978882 B1	15.08.2007
		EP 1870943 A2	26.12.2007
		EP 1870943 A3	12.03.2008
		EP 1870943 B1	29.04.2009
		ES 22922 16 T3	01.03.2008
		ES 2323904 T3	27.07.2009
		JP 04-303363 B2	01.05.2009
		JP 4303363 B2	29.07.2009
		US 06127202A A	03.10.2000
		US 2007-0163637 A1	19.07.2007
CN 10106 1588 B	22.12.2010		
CN 101 128941 A	20.02.2008		
CN 101 128941 CO	20.02.2008		
CN 101268608 AO	17.09.2008		
CN 101336487 A	31.12.2008		
CN 101438416 A	20.05.2009		
CN 101443130 A	27.05.2009		
CN 101443892 A	27.05.2009		
CN 1014439 19 A	27.05.2009		
CN 10144392 1 A	27.05.2009		
CN 101506990 A	12.08.2009		
CN 101506995 A	12.08.2009		
CN 102136522 A	27.07.2011		
EP 1723265 A2	22.11.2006		
EP 1747590 A2	31.01.2007		
EP 1805804 A1	11.07.2007		
EP 1805804 B1	24.03.2010		
EP 1849191 A2	31.10.2007		
EP 18619 16 A2	05.12.2007		
EP 1935086 A2	25.06.2008		
EP 1949528 A2	30.07.2008		
EP 1961047 A2	27.08.2008		
EP 19920 10 A2	19.11.2008		
EP 1997149 A2	03.12.2008		
EP 1997150 A2	03.12.2008		
EP 1998902 A2	10.12.2008		
EP 1999796 A2	10.12.2008		
EP 2230693 A1	22.09.2010		
EP 2230693 B1	04.01.2012		

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2011/051817

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		EP 2348540 A2	27.07.2011
		EP 2348540 A3	09.11.2011
		JP 04-729007 B2	22.04.2011
		JP 04-794577 B2	05.08.2011
		JP 2008-514006 A	01.05.2008
		JP 2008-52928 1 A	31.07.2008
		JP 2008-537640 A	18.09.2008
		JP 2009-0036 18 A	08.01.2009
		JP 2009-505430 A	05.02.2009
		JP 2009-528680 A	06.08.2009
		JP 2009-52868 1 A	06.08.2009
		JP 2009-528682 A	06.08.2009
		JP 2009-529805 A	20.08.2009
		JP 2009-540537 A	19.11.2009
		JP 4729007 B2	20.07.2011
		KR 10-2007-0064345 A	20.06.2007
		KR 10-2008-0052596 A	11.06.2008
		US 2005-0183767 A1	25.08.2005
		US 2005-0183768 A1	25.08.2005
		US 2005-0186338 A1	25.08.2005
		US 2005-0186342 A1	25.08.2005
		US 2006-0060237 A1	23.03.2006
		US 2006-0062902 A1	23.03.2006
		us 2006-0153985 A1	13.07.2006
		us 2006-0157 103 A1	20.07.2006
		us 2006-016026 1 A1	20.07.2006
		us 2006-0207644 A1	21.09.2006
		us 2007-0000537 A1	04.01.2007
		us 2007-0074755 A1	05.04.2007
		us 2007-0092648 A1	26.04.2007
		us 2007-0163383 A1	19.07.2007
		us 2007-0163638 A1	19.07.2007
		us 2007-0163639 A1	19.07.2007
		us 2007-0163640 A1	19.07.2007
		us 2007-0163641 A1	19.07.2007
		us 2007-0163642 A1	19.07.2007
		us 2007-0163643 A1	19.07.2007
		us 2007-0163644 A1	19.07.2007
		us 2007-0166453 A1	19.07.2007
		us 2007-0169809 A1	26.07.2007
		us 2007-01698 10 A1	26.07.2007
		us 2007-01698 11 A1	26.07.2007
		us 2007-01698 12 A1	26.07.2007
		us 2007-01698 13 A1	26.07.2007
		us 2007-018697 1 A1	16.08.2007
		us 2008-0020503 A1	24.01.2008
		us 2008-012 1277 A1	29.05.2008
		us 2008-012483 1 A1	29.05.2008
		us 2008-0135099 A1	12.06.2008
		us 2008-01358 11 A1	12.06.2008

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2011/051817

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		us 2008-01358 12 A1	12. 06 ,2008
		us 2008-013850 1 A1	12. 06 .2008
		us 2008-0142072 A1	19. 06 ,2008
		us 2008-0142073 A1	19. 06 ,2008
		us 2008-0142080 A1	19. 06 ,2008
		us 2008-014208 1 A1	19. 06 ,2008
		us 2008-0142082 A1	19. 06 .2008
		us 2008-0142083 A1	19. 06 ,2008
		us 2008-0142084 A1	19. 06 ,2008
		us 2008-0149 176 A1	26. 06 ,2008
		us 2008-02 13467 A1	04. 09 ,2008
		us 2008-0308 148 A1	18. 12 .2008
		us 2009-00060 12 A1	0 1. 0 1 ,2009
		us 2009-0178706 A1	16. 07 ,2009
		us 2009-0246906 A1	0 1. 10 ,2009
		us 2009-0305455 A1	10. 12 ,2009
		us 2010-0089453 A1	15. 04 ,2010
		us 2010-00960 15 A1	22. 04 ,2010
		us 2010-0170564 A1	08. 07 ,2010
		us 2010-0243049 A1	30. 09 .2010
		us 2010-0267 189 A1	2 1. 10 ,2010
		us 2010-0267222 A1	2 1. 10 ,2010
		us 201 1-00920 10 A1	2 1. 04 ,201 1
		us 201 1-012 1353 A1	26. 05 ,201 1
		us 7 115304 B2	03. 10 .2006
		us 7276724 B2	02. 10 ,2007
		us 7306823 B2	11. 12 ,2007
		us 7604843 B1	20. 10 ,2009
		us 7605328 B2	20. 10 ,2009
		us 7663057 B2	16. 02 .2010
		us 7700464 B2	20. 04 ,2010
		us 7732229 B2	08. 06 ,2010
		us 7732232 B2	08. 06 .2010
		us 7838868 B2	23. 11 ,2010
		us 7858151 B2	28. 12 ,2010
		us 7908100 B2	15. 03 ,201 1
		us 7919337 B2	05. 04 ,201 1
		us 7968869 B2	28. 06 .201 1
		us 8038909 B2	18. 10 ,201 1
		us 8048477 B2	0 1. 11 ,201 1
		us 8088309 B2	03. 0 1 ,2012
		Wo 2005-08 1788 A2	09. 09 ,2005
		Wo 2005-08 1788 A3	09. 09 .2005
		wo 2005-08 1789 A3	09. 09 ,2005
		wo 2006-033858 A1	30. 03 ,2006
		wo 2006-073437 A3	13. 07 .2006
		wo 2006-078985 A3	27. 07 ,2006
		wo 2006- 10 1986 A3	28. 09 ,2006
		wo 2006- 135377 A3	2 1. 12 ,2006
		wo 2007-02222 1 A3	22. 02 ,2007

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2011/051817

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		W0 2007-041533 A3	12. 04. 2007
		w0 2007-065096 A3	07. 06. 2007
		w0 2007- 10 1099 A3	07. 09. 2007
		w0 2007- 10 1135 A3	07. 09. 2007
		w0 2007- 10 1136 A3	07. 09. 2007
		w0 2007- 10 1138 A3	07. 09. 2007
		w0 2007- 106756 A2	20. 09. 2007
		w0 2007- 106756 A3	20. 09. 2007
US 2007-0163639 A1	19. 07. 2007	CN 10106 1588 AO	24. 10. 2007
		CN 10106 1588 B	22. 12. 2010
		CN 101 128941 A	20. 02. 2008
		CN 101 128941 CO	20. 02. 2008
		CN 101268608 AO	17. 09. 2008
		CN 101336487 A	31. 12. 2008
		CN 101438416 A	20. 05. 2009
		CN 101443130 A	27. 05. 2009
		CN 101443892 A	27. 05. 2009
		CN 101443919 A	27. 05. 2009
		CN 101443921 A	27. 05. 2009
		CN 101506990 A	12. 08. 2009
		CN 101506995 A	12. 08. 2009
		CN 102136522 A	27. 07. 2011
		EP 1723265 A2	22. 11. 2006
		EP 1747590 A2	31. 01. 2007
		EP 1805804 A1	11. 07. 2007
		EP 1805804 B1	24. 03. 2010
		EP 1849191 A2	31. 10. 2007
		EP 1861916 A2	05. 12. 2007
		EP 1935086 A2	25. 06. 2008
		EP 1949528 A2	30. 07. 2008
		EP 1961047 A2	27. 08. 2008
		EP 1992010 A2	19. 11. 2008
		EP 1997149 A2	03. 12. 2008
		EP 1997150 A2	03. 12. 2008
		EP 1998902 A2	10. 12. 2008
		EP 1999796 A2	10. 12. 2008
		EP 2230693 A1	22. 09. 2010
		EP 2230693 B1	04. 01. 2012
		EP 2348540 A2	27. 07. 2011
		EP 2348540 A3	09. 11. 2011
		JP 04-729007 B2	22. 04. 2011
		JP 04-794577 B2	05. 08. 2011
		JP 2008-514006 A	01. 05. 2008
		JP 2008-52928 1 A	31. 07. 2008
		JP 2008-537640 A	18. 09. 2008
		JP 2009-003618 A	08. 01. 2009
		JP 2009-505430 A	05. 02. 2009
		JP 2009-528680 A	06. 08. 2009
		JP 2009-52868 1 A	06. 08. 2009

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2011/051817

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		JP 2009-528682 A	06.08.2009
		JP 2009-529805 A	20.08.2009
		JP 2009-540537 A	19.11.2009
		JP 4729007 B2	20.07.2011
		KR 10-2007-0064345 A	20.06.2007
		KR 10-2008-0052596 A	11.06.2008
		US 2005-0183767 A 1	25.08.2005
		US 2005-0183768 A 1	25.08.2005
		US 2005-0186338 A 1	25.08.2005
		US 2005-0186342 A 1	25.08.2005
		US 2006-0060237 A 1	23.03.2006
		US 2006-0062902 A 1	23.03.2006
		US 2006-0153985 A 1	13.07.2006
		US 2006-0157103 A 1	20.07.2006
		US 2006-0160261 A 1	20.07.2006
		US 2006-0207644 A 1	21.09.2006
		US 2007-0000537 A 1	04.01.2007
		US 2007-0074755 A 1	05.04.2007
		US 2007-0092648 A 1	26.04.2007
		US 2007-0163383 A 1	19.07.2007
		US 2007-0163637 A 1	19.07.2007
		US 2007-0163638 A 1	19.07.2007
		US 2007-0163640 A 1	19.07.2007
		US 2007-0163641 A 1	19.07.2007
		US 2007-0163642 A 1	19.07.2007
		US 2007-0163643 A 1	19.07.2007
		US 2007-0163644 A 1	19.07.2007
		US 2007-0166453 A 1	19.07.2007
		US 2007-0169809 A 1	26.07.2007
		US 2007-0169810 A 1	26.07.2007
		US 2007-0169811 A 1	26.07.2007
		US 2007-0169812 A 1	26.07.2007
		US 2007-0169813 A 1	26.07.2007
		US 2007-0186971 A 1	16.08.2007
		US 2008-0020503 A 1	24.01.2008
		US 2008-0121277 A 1	29.05.2008
		US 2008-0124831 A 1	29.05.2008
		US 2008-0135099 A 1	12.06.2008
		US 2008-0135811 A 1	12.06.2008
		US 2008-0135812 A 1	12.06.2008
		US 2008-0138501 A 1	12.06.2008
		US 2008-0142072 A 1	19.06.2008
		US 2008-0142073 A 1	19.06.2008
		US 2008-0142080 A 1	19.06.2008
		US 2008-0142081 A 1	19.06.2008
		US 2008-0142082 A 1	19.06.2008
		US 2008-0142083 A 1	19.06.2008
		US 2008-0142084 A 1	19.06.2008
		US 2008-0149176 A 1	26.06.2008
		US 2008-0213467 A 1	04.09.2008

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2011/051817

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		us 2008-0308 148 A1	18. 12 ,2008
		us 2009-00060 12 A1	01. 01 .2009
		us 2009-0178706 A1	16. 07 ,2009
		us 2009-0246906 A1	01. 10 ,2009
		us 2009-0305455 A1	10. 12 ,2009
		us 2010-0089453 A1	15. 04 ,2010
		us 2010-00960 15 A1	22. 04 .2010
		us 2010-0170564 A1	08. 07 ,2010
		us 2010-0243049 A1	30. 09 ,2010
		us 2010-0267 189 A1	21. 10 ,2010
		us 2010-0267222 A1	21. 10 ,2010
		us 2011-00920 10 A1	21. 04 .2011
		us 2011-012 1353 A1	26. 05 ,2011
		us 7115304 B2	03. 10 ,2006
		us 7276724 B2	02. 10 ,2007
		us 7306823 B2	11. 12 ,2007
		us 7604843 B1	20. 10 ,2009
		us 7605328 B2	20. 10 ,2009
		us 7663057 B2	16. 02 ,2010
		us 7700464 B2	20. 04 .2010
		us 7732229 B2	08. 06 ,2010
		us 7732232 B2	08. 06 ,2010
		us 7838868 B2	23. 11 ,2010
		us 7858151 B2	28. 12 ,2010
		us 7908100 B2	15. 03 .2011
		us 7919337 B2	05. 04 ,2011
		us 7968869 B2	28. 06 ,2011
		us 8038909 B2	18. 10 ,2011
		us 8048477 B2	01. 11 ,2011
		us 8088309 B2	03. 01 .2012
		Wo 2005-08 1788 A2	09. 09 ,2005
		Wo 2005-08 1788 A3	09. 09 ,2005
		wo 2005-08 1789 A2	09. 09 .2005
		wo 2005-08 1789 A3	09. 09 ,2005
		wo 2006-033858 A1	30. 03 ,2006
		wo 2006-073437 A3	13. 07 ,2006
		wo 2006-078985 A3	27. 07 ,2006
		wo 2006- 10 1986 A3	28. 09 .2006
		wo 2006- 135377 A3	21. 12 ,2006
		wo 2007-0222? 1 A3	22. 02 ,2007
		wo 2007-041533 A3	12. 04 ,2007
		wo 2007-065096 A3	07. 06 ,2007
		wo 2007- 10 1099 A3	07. 09 .2007
		wo 2007- 10 1135 A3	07. 09 ,2007
		wo 2007- 10 1136 A3	07. 09 ,2007
		wo 2007- 10 1138 A3	07. 09 .2007
		wo 2007- 106756 A2	20. 09 ,2007
		wo 2007- 106756 A3	20. 09 ,2007