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Breen et al.

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(54) **PLASTIC SOLAR DYE CELLS**
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(*) Notice: Subject to any disclaimer, the term of this
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H01L 51/00 (2006.01)
(52) **U.S. Cl.**
CPC **H01G 9/2077** (2013.01); **H01G 9/0036**
(2013.01); **H01G 9/2031** (2013.01); **H01G**
9/2095 (2013.01); **H01G 9/2059** (2013.01);
H01L 51/003 (2013.01); **Y02E 10/542**
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CPC **H01L 51/003**
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PCT Pub. Date: **Jan. 22, 2015**

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(65) **Prior Publication Data**
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EP 1589548 A1 10/2005
WO 2011009631 A1 1/2011

Related U.S. Application Data
(60) Provisional application No. 61/846,093, filed on Jul.
15, 2013.

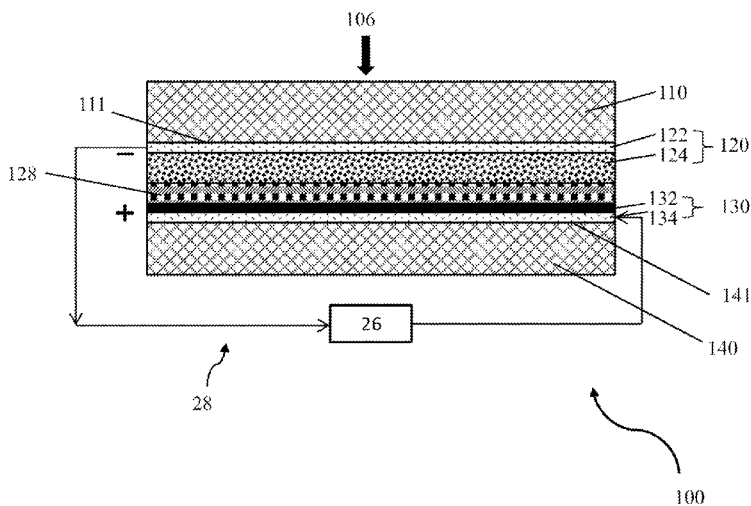
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(51) **Int. Cl.**
H02N 6/00 (2006.01)
H01L 31/042 (2014.01)
H01L 21/00 (2006.01)
H01G 9/20 (2006.01)

Primary Examiner — Angelo Trivisonno
(74) *Attorney, Agent, or Firm* — Marc Van Dyke

(57) **ABSTRACT**
Solar dye cells having a plastic housing, and methods of
construction such solar dye cells.

20 Claims, 12 Drawing Sheets





(12) **United States Patent**
Goldstein et al.

(10) **Patent No.:** **US 9,704,653 B2**
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- (54) **PHOTOVOLTAIC CELL**
- (71) Applicant: **3GSOLAR PHOTOVOLTAICS LTD.**,
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- (72) Inventors: **Jonathan R. Goldstein**, Jerusalem (IL);
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- (73) Assignee: **3GSOLAR PHOTOVOLTAICS LTD.**,
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- (*) Notice: Subject to any disclaimer, the term of this
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(21) Appl. No.: **14/562,728**
(22) Filed: **Dec. 7, 2014**

(65) **Prior Publication Data**
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(52) **U.S. Cl.**
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(Continued)

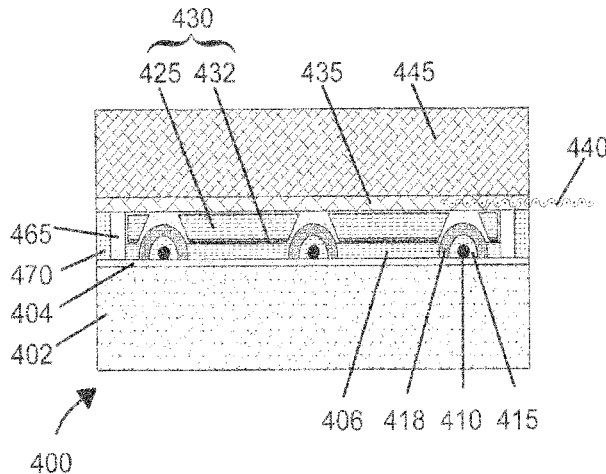
(58) **Field of Classification Search**
CPC .. H01G 9/2013; H01G 9/2018; H01G 9/2022;
H01G 9/2027; H01G 9/2031; H01G
9/2059; H01G 9/2068; H01G 9/2077
See application file for complete search history.

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Primary Examiner — Bethany L Martin
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(57) **ABSTRACT**
A photovoltaic cell including: (a) a housing adapted to
enclose the photovoltaic cell, and including an at least
partially transparent cell wall; (b) an electrolyte, disposed
within the cell wall, and containing a corrosive redox
species; (c) an at least partially transparent conductive
coating disposed on an interior surface of the cell wall,
within the photovoltaic cell; (d) an anode disposed on the
conductive coating, the anode including a porous film
adapted to make intimate contact with the redox species, and
a dye, absorbed on a surface of the porous film, the dye and
the film adapted to convert photons to electrons; (e) a
cathode, disposed within an interior surface of the housing
and disposed substantially opposite the anode, including a
conductive carbon layer, and a catalytic component, asso-
ciated with the carbon layer and adapted to catalyze a redox
reaction, the carbon layer adapted to transfer electrons from
the cathode, and (f) at least one metal strip or wire, electri-
cally associated with the anode and with the conductive
coating, the strip or wire having sufficient thickness to form
a protrusion protruding above a plane of the porous film by
at least 50 micrometers, wherein a distance between a
surface of the catalytic component and a surface of the
porous film is less than 20 micrometers.

20 Claims, 20 Drawing Sheets



(12) **United States Patent**
Goldstein

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(54) **SOLAR CELL DEVICE**

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(72) Inventor: **Jonathan Goldstein, Jerusalem (IL)**

(73) Assignee: **3GSOLAR PHOTOVOLTAICS LTD.,**
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(21) Appl. No.: **15/089,597**

(22) Filed: **Apr. 4, 2016**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 14/658,661, filed on Mar. 16, 2015, now Pat. No. 9,305,714, which is a continuation of application No. 14/082,460, filed on Nov. 18, 2013, now Pat. No. 8,981,206, which is a continuation of application No. 12/814,523, filed on (Continued)

Foreign Application Priority Data

Jan. 12, 2003 (IL) 153895

(51) **Int. Cl.**
H01G 9/20 (2006.01)

(52) **U.S. Cl.**
CPC **H01G 9/2077** (2013.01); **H01G 9/2018** (2013.01); **H01G 9/2031** (2013.01)

(58) **Field of Classification Search**

CPC . H01L 31/048; H01L 31/0485; H01L 31/0488
See application file for complete search history.

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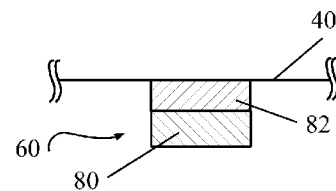
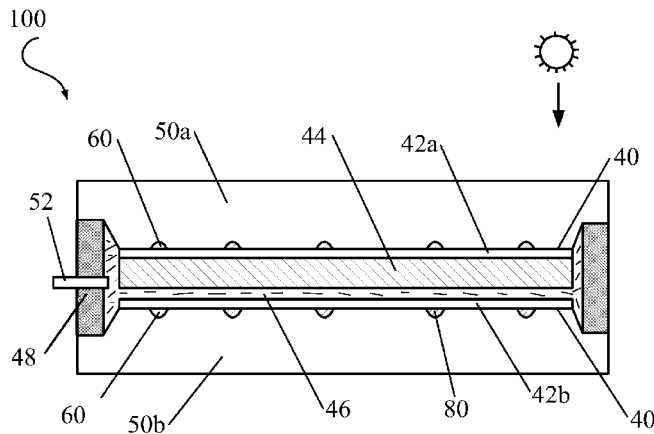
Primary Examiner — Golam Mowla

(74) *Attorney, Agent, or Firm* — Marc Van Dyke

(57) **ABSTRACT**

A photovoltaic cell including: (a) a housing including an at least partially transparent cell wall having an interior surface; (b) an electrolyte, disposed within the cell wall, and containing an iodide based species; (c) a transparent electrically conductive coating disposed on the interior surface; (d) an anode disposed on the conductive coating, the anode including: (i) a porous film containing titania, the porous film adapted to make intimate contact with the iodide based species, and (ii) a dye, absorbed on a surface of the porous film, the dye and the porous film adapted to convert photons to electrons; (e) a cathode disposed on an interior surface of the housing, and disposed substantially opposite the anode; (f) electrically-conductive metallic wires, disposed at least partially within the cell, the wires electrically contacting the anode and the electrically conductive coating, and (g) a second electrically conductive coating including an inorganic binder and an inorganic electrically conductive filler, the second coating bridging between and electrically communicating between each of the wires and the transparent coating, the wires adapted to boost collection of a current generated by the cell.

20 Claims, 8 Drawing Sheets





(12) **United States Patent**
Goldstein

(10) **Patent No.:** **US 9,305,714 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

- (54) **SOLAR CELL DEVICE**
- (71) Applicant: **3GSOLAR PHOTOVOLTAICS LTD.**,
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- (72) Inventor: **Jonathan Goldstein, II (IL)**
- (73) Assignee: **3GSOLAR PHOTOVOLTAICS LTD.**,
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- (*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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- (21) Appl. No.: **14/658,661**
- (22) Filed: **Mar. 16, 2015**
- (65) **Prior Publication Data**
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Related U.S. Application Data

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Nov. 18, 2013, now Pat. No. 8,981,206, which is a
continuation of application No. 12/814,523, filed on
Jun. 14, 2010, now Pat. No. 8,586,861, which is a
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Foreign Application Priority Data

- (30) Jan. 12, 2003 (IL) 153895
- (51) **Int. Cl.**
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- (52) **U.S. Cl.**
CPC **H01G 9/2031** (2013.01); **H01G 9/2068**
(2013.01); **Y02E 10/542** (2013.01)
- (58) **Field of Classification Search**
CPC H01L 31/048; H01L 31/0485; H01L
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USPC 136/251, 252, 256, 263
See application file for complete search history.

- (56) **References Cited**
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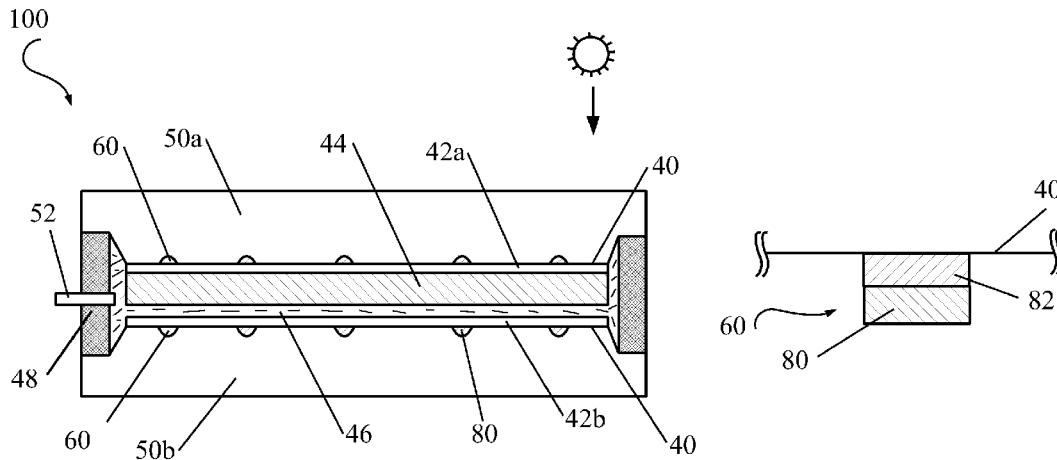
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Primary Examiner — Golam Mowla
(74) *Attorney, Agent, or Firm* — Marc Van Dyke

ABSTRACT

(57) A photovoltaic cell including: (a) a housing including an at least partially transparent cell wall having an interior surface; (b) an electrolyte, disposed within the cell wall, and containing an iodide based species; (c) a transparent electrically conductive coating disposed on the interior surface; (d) an anode disposed on the conductive coating, the anode including: (i) a porous film containing titania, the porous film adapted to make intimate contact with the iodide based species, and (ii) a dye, absorbed on a surface of the porous film, the dye and the porous film adapted to convert photons to electrons; (e) a cathode disposed on an interior surface of the housing, and disposed substantially opposite the anode; (f) electrically-conductive metallic wires, disposed at least partially within the cell, the wires electrically contacting the anode and the electrically conductive coating, and (g) a second electrically conductive coating including an inorganic binder and an inorganic electrically conductive filler, the second coating bridging between and electrically communicating between each of the wires and the transparent coating, the wires adapted to boost collection of a current generated by the cell.

18 Claims, 8 Drawing Sheets



(12) **United States Patent**
Goldstein

(10) **Patent No.:** **US 8,981,206 B2**
(45) **Date of Patent:** ***Mar. 17, 2015**

(54) **SOLAR CELL DEVICE**
(71) Applicant: **3GSolar Photovoltaics Ltd.**, Jerusalem (IL)
(72) Inventor: **Jonathan Goldstein**, Jerusalem (IL)
(73) Assignee: **3GSolar Photovoltaics Ltd.**, Jerusalem (IL)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
This patent is subject to a terminal disclaimer.

(58) **Field of Classification Search**
USPC 136/251, 252, 256, 259; 257/433; 438/64, 66, 98
See application file for complete search history.

(56) **References Cited**
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(21) Appl. No.: **14/082,460**
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Primary Examiner — Golam Mowla
(74) *Attorney, Agent, or Firm* — Marc Van Dyke

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(Continued)

(57) **ABSTRACT**
A photovoltaic cell including: (a) a housing including an at least partially transparent cell wall having an interior surface; (b) an electrolyte, containing an iodide based species; (c) a transparent electrically conductive coating disposed on the interior surface; (d) an anode disposed on the conductive coating, the anode including: (i) a porous film containing titania, the porous film adapted to make intimate contact with the iodide based species, and (ii) a dye, absorbed on a surface of the porous film, the dye and the porous film adapted to convert photons to electrons; (e) a cathode disposed on an interior surface of the housing; (f) electrically-conductive metallic wires, disposed within the cell, and electrically contacting the anode and the coating, and (g) a second electrically conductive coating including an inorganic binder and an inorganic electrically conductive filler, the second coating bridging between each of the wires and the transparent coating.

(30) **Foreign Application Priority Data**
Jan. 12, 2003 (IL) 153895
(51) **Int. Cl.**
H01G 9/20 (2006.01)
(52) **U.S. Cl.**
CPC **H01G 9/2031** (2013.01); **H01G 9/2068** (2013.01); **Y02E 10/542** (2013.01)
USPC **136/251**; 136/252; 136/256; 136/259; 438/64; 438/66; 438/98; 257/433

20 Claims, 8 Drawing Sheets

