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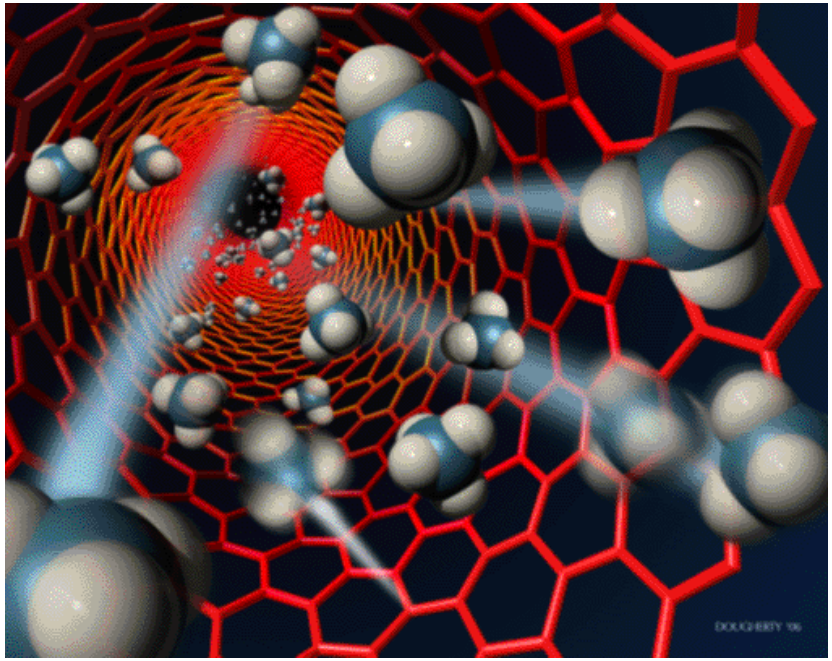

Overview of Recent Patent Activity in Nanotech-Enabled Power Systems

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Partner

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Search strategy

- **USPTO CLASS 977, NANOTECHNOLOGY**
- **902 SPECIFIED USE OF NANOSTRUCTURE:**
- **932 . For electronic or optoelectronic application**
- **948 .. Energy storage/generating using nanostructure (e.g., fuel cell, battery, etc.)**

“Nano-Power” Patents and Applications

- About 50 newly published patents and applications in the last six months
  - Li Batteries ~ 18
  - Solar ~13
  - Fuel cells ~7
  - Supercapacitors ~7
  - Nanomaterials, generally ~7
  - Thermoelectrics ~1
  - Thermal power sources ~1

Li Batteries Nanopatents since Sep2013

- Nanomaterials
  - Electrodes
  - Separators
- Companies
  - Applied Materials
  - Shenzhen BYD Auto
  - CNano Technology
  - Nanotune Technologies
  - Individuals (mostly Chinese)

Nanotune Technologies, Mountainview, Calif.

- Nanoporous energy chips and related devices and methods
- US 20130309591 A1
- Kuan-Tsae HUANG, Shiho Wang, Cheuk Wun WONG, Jaspal Singh, Yudi YUDI

Nanoporous energy chips and related devices and methods

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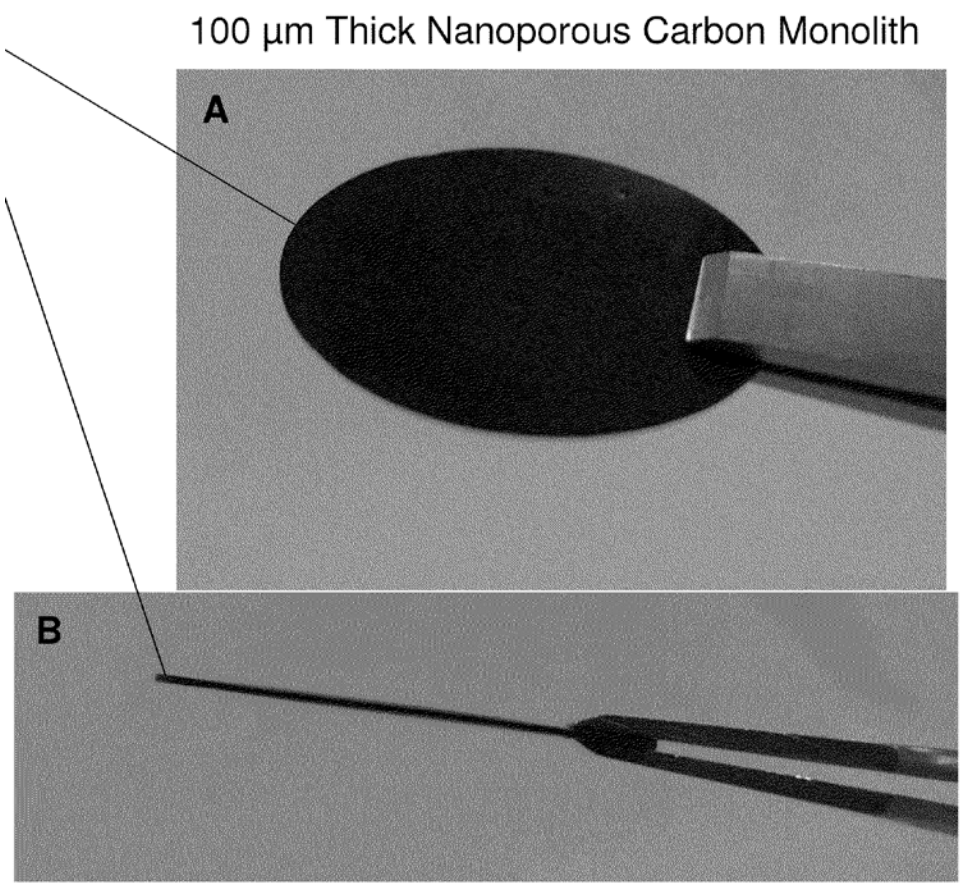
1. A nanoporous energy chip for use in an energy storage device, comprising:

a monolithic conductive material comprising an open network of pores of avg diameter between 0.3 nm and 30 nm, and

wherein the conductive material forms a thin chip less than 300 microns thick, the thickness across different portions of the chip varies by less than 10%.



IBM

- Techniques for enhancing efficiency of photovoltaic devices using high-aspect-ratio nanostructures
- US 8551558 B2
- Supratik Guha, Oki Gunawan

Techniques for enhancing efficiency of photovoltaic devices using high-aspect-ratio nanostructures

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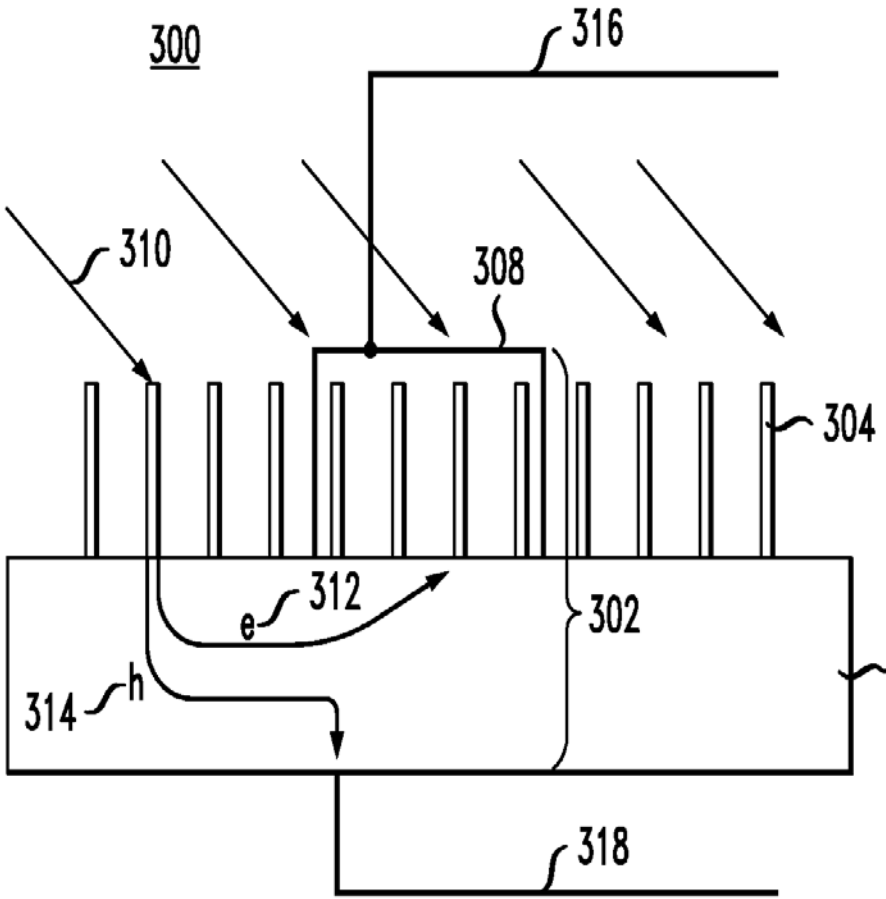
1. A method of fabricating a photovoltaic device, comprising …

forming high-aspect-ratio nanostructures on surfaces of a photoactive layer configured to act as a scattering media for incident light;

forming a metal layer on, and in contact with, the photoactive layer, wherein a Schottky junction is formed …

the metal layer covers only some of the plurality of high-aspect-ratio nanostructures leaving one or more of the plurality of high-aspect-ratio nanostructures completely uncovered and unobstructed by the metal layer …

to aid in capturing and absorbing incident light and to generate charge carrier electron-hole pairs...



Solar Nanopatents since Sep2013

- Nanomaterials
  - Sensitized Dye
- Companies
  - IBM
  - Samsung
  - Plextronics
  - Cambridge Enterprise Ltd
  - Chinese Universities and Labs

Fuel Cell Nanopatents since Sep2013

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- Materials
  - Separators
  - Catalysts
- Companies
  - GM
  - Nissan North America
  - Samsung

GM

- Lithium battery with silicon-based anode and silicate-based cathode
- US 20130234674 A1
- Gholam-Abbas Nazri

Lithium battery with silicon-based anode and silicate-based cathode

- **1**. A lithium-ion battery comprising: a lithium silicate-based electrode comprising flake-like Olivine structures; and a carbon fiber-based electrode comprising a plurality of carbon nanofiber cores each having a silicon layer and a protective layer.

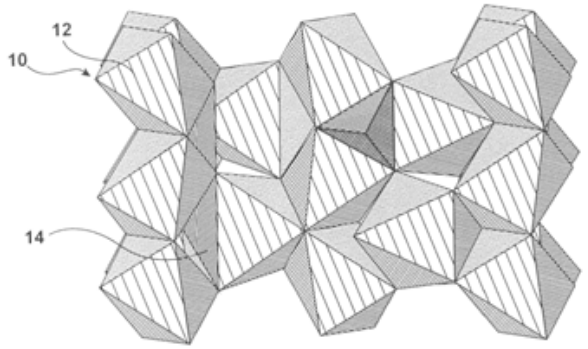

Fig. 1

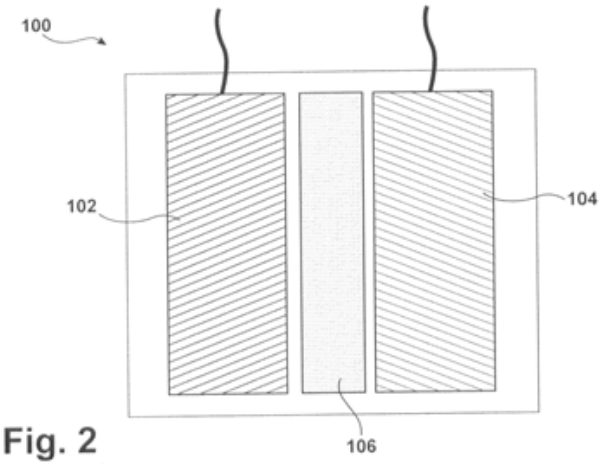

Fig. 2

Nissan North America

- Ultralow loading fuel cell catalyst
- US 20140004440 A1
- Taehee Han, Ellazar V. Niangar, Nilesh Dale

Ultralow loading fuel cell catalyst

20. A fuel cell comprising a plurality of membrane electrode assemblies each comprising:

- an ultralow loading catalyst having catalyst particles comprising:
- a support particle comprised of a carbon-nitrogen-transition metal network having a first set of active sites; and
- precious metal particles supported on the support particle and having a second set of active sites.

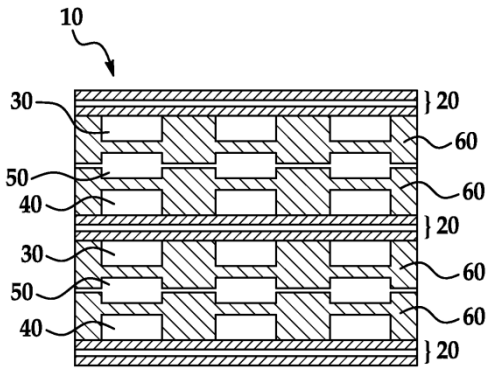

FIG. 1

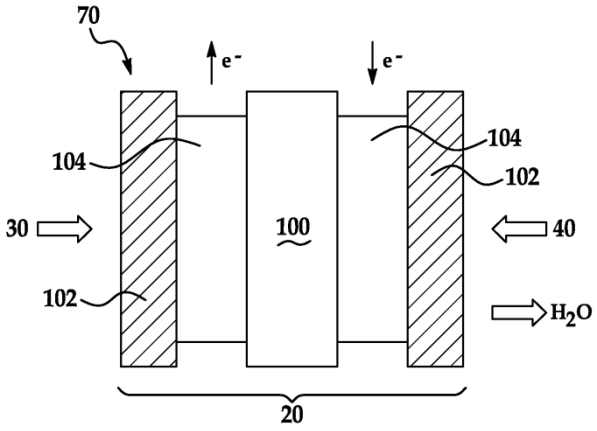

FIG. 2

Supercapacitor Nanopatents since Sep2013

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- Nanomaterials
  - Graphene
  - Nanoporous for chemical storage and transport
- Companies
  - Applied Materials
  - University of Chicago / Argonne Nat Lab
  - Bluestone Global Technologies

Applied Materials

- 3D approach on battery and supercapitor fabrication by initiation chemical vapor deposition techniques
- US 8603195 B2
- Victor L. Pushparaj, Pravin K. Narwankar, Omkaram Nalamasu

3D approach on battery and supercapitor fabrication by initiation chemical vapor deposition techniques

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1. A method of producing an energy storage device, comprising:

- positioning an anodic current collector into a processing region;
- depositing one or more three-dimensional electrodes separated by a finite distance on a surface of the anodic current collector such that portions of the surface of the anodic current collector remain exposed;
- selectively depositing an insulator layer …;
- depositing a conformal polymeric layer over the insulator …;
- flowing a gaseous initiator into the processing region through a heated filament to form a reactive gas mixture …;
- depositing a conformal layer of cathodic material ...

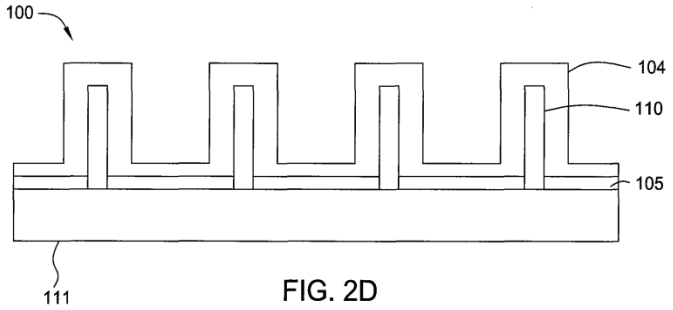

FIG. 2D

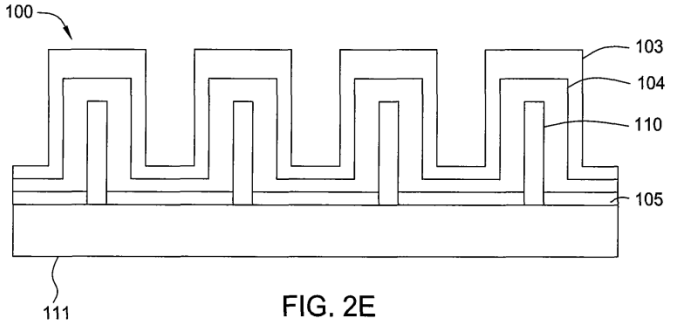

FIG. 2E

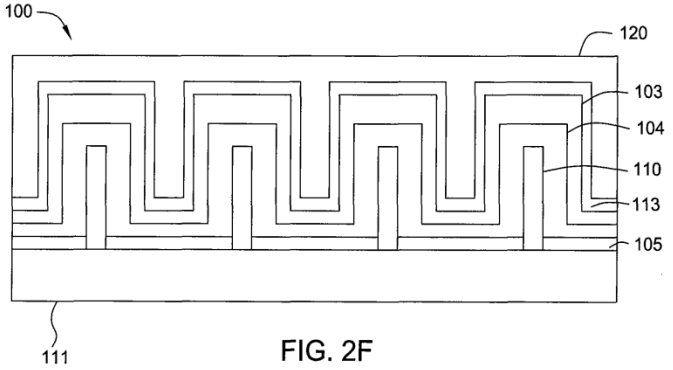

FIG. 2F

Nanomaterials Patents Since Sep2014

- Nanomaterials
  - Graphene
  - Electrodes
  - Separators
  - Storage Media
  - Semiconductors
- Companies (all)
  - Nanosys, Inc.
  - Chinese

Other Nanopatents since Sep2013

- Thermoelectrics
  - Hamilton Sundstrand Space Systems
- Thermal Power Sources
  - Gwangju Inst. Sci & Tech
  - Seerstone,Llc (Nuclear Batteries)

Hamilton Sundstrand Space Systems

- Concentrated photovoltaic/quantum well thermoelectric power source
- US 20130291919 A1
- Cheng-Yi Lu

Concentrated photovoltaic/quantum well thermoelectric power source

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11. A composite concentrated photovoltaic/thermoelectric power source comprising:

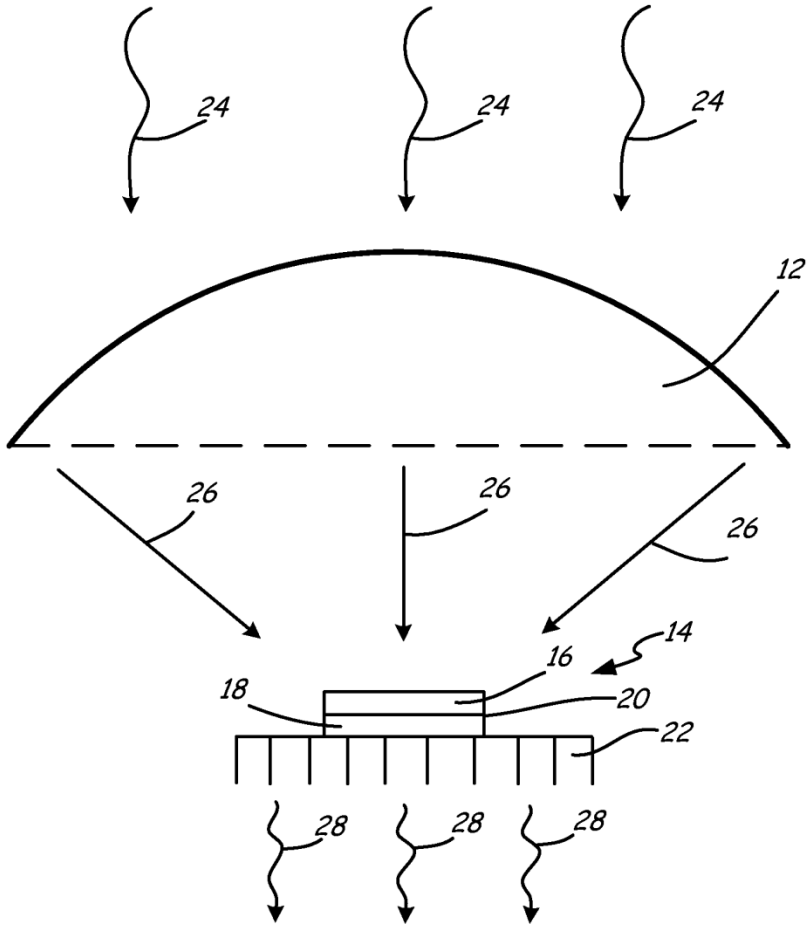
a focusing lens module for concentrating incident solar radiation;

a photovoltaic module with a first surface for transforming incident concentrated solar radiation from the lens module into electrical power;

a thermoelectric module with a second surface receiving heat transmitted from the photovoltaic module;

a thermally conducting and electrically insulating layer with a top surface in contact with the first surface of the photovoltaic module and a bottom surface in contact with the second surface of the thermoelectric module; and

a heat sink in contact with the thermoelectric module.



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