NEW DEVELOPMENTS IN PHOTOVOLTAIC DYE CELLS AT 3GSOLAR

JONATHAN GOLDSTEIN, BARRY BREEN AND MICHAEL SCHWARTZ

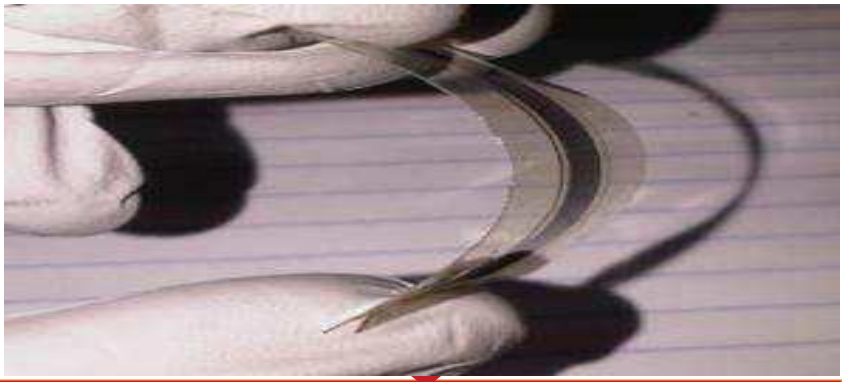
EILAT RENEWABLE ENERGY CONFERENCE NOVEMBER 2012

3GSOLAR PRINTED SOLAR CELLS AND APPLICATIONS

3GSOLAR – THE LEADING DEVELOPER OF PRINTED DYE SOLAR CELLS

LARGE GLASS POWER MODULES FOR ON-GRID AND OFF-GRID ELECTRICITY

FLEXIBLE PLASTIC CELLS FOR INDOOR ENERGY HARVESTING



GLASS AND PLASTIC MODULES FOR BIPV

Glass and polymer modules for curtain walls and windows

Thin modules for windows, greenhouses, overhangs

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Solar Energy Modules

MANAGEMENT & TECHNICAL TEAM

WORLD CLASS EXPERTISE

BARRY N. BREEN **CEO**	• Thin film process development expert; 16 years in senior positions at AVX; Four years at GE. • Recognized for outstanding achievement in product and business development: Kaplan Prize and Kyocera Corporation President Award. • B.Sc. in Nuclear Engineering from MIT.
DR. JONATHAN GOLDSTEIN **PRESIDENT AND FOUNDER**	• Electrochemist with specialization in batteries, fuel cells, solar energy and materials; holder of 41 patents. • PhD in Chemistry from City University, London.
DR. MICHAEL SCHWARTZ **CTO**	• Materials Chemist with over 20 years industrial and academic experience developing electroactive materials; holder of 14 patents. • Ph.D. in Chemistry from the University of North Carolina, Chapel Hill.

3GSOLAR FINANCIAL AND BUSINESS PARTNERS

INTERNATIONAL TEAM

SMEDVIG GROUP

- 3GSolar's largest shareholder is a fund affiliated to the $1.5 billion Smedvig Group.
- Highly involved with 3GSolar management on strategy, finance and business development.

ISRAEL ELECTRIC COMPANY (IEC)

- Israel's national electricity supplier. Invested June 2011.

HUAXIANG GROUP OF NINGBO, CHINA

- Investment made April 2012 by Ningbo Huayou Real-Estate Company of the HuaXiang Group.

HUAXIANG PRESIDENT & NINGBO DIGNITARIES

VISIT TO OUR FACILITY IN JERUSALEM -3GSOLAR INVESTMENT PARTNERS SINCE APRIL 2012

3GSOLAR IS ACTIVELY SEARCHING ADDITIONAL INVESTMENT FROM INTERESTED PARTIES FOR FURTHER DEVELOPMENT INCLUDING ENTRY TO PILOT PHASE FOR CELL AND MODULE MANUFACTURE

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3GSOLAR AND ITS PARTNERS

COMPANY GOAL TO GAIN A LARGE PART OF THE DSC MODULE MARKET

3GSolar developed the largest single cell DSC and it produces the highest current

3GSolar is the leader in DSC durability and cost prognosis

3GSolar demonstrated that the technology can be transferred to flexible substrates

The exceptional international team at 3GSolar is consistently making new gains in DSC performance

Approaching goal for glass modules-10% efficiency

Approaching goal for plastic modules- 5% efficiency

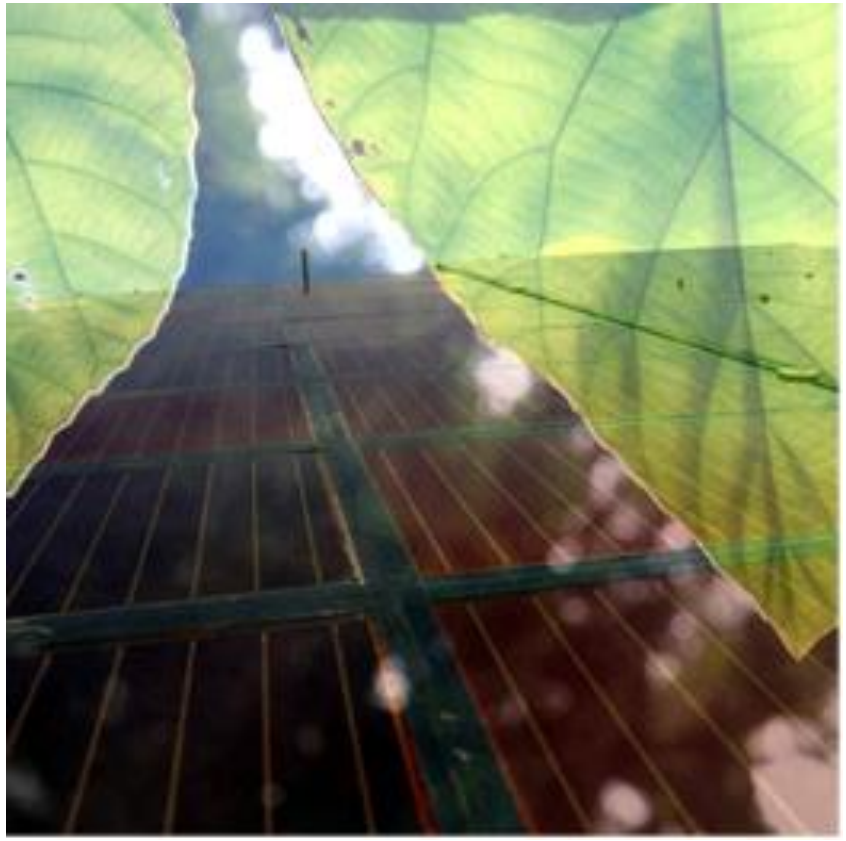
3GSolar technology with industrial partners will take a large part of the upcoming $4.4B DSC market*

* Market size projection by NanoMarkets in the 2012 report Dye Sensitized Cell Markets for the year 2019 DSC market

TECHNOLOGY DESCRIPTION

INORGANIC PHOTOSYNTHESIS

- DSC invented by Professor Michael Graetzel and Brian O'Regan at the École Polytechnique Fédérale de Lausanne (EPFL), Switzerland.
- DSC is derived from nature itself, replicating the natural process of photosynthesis using a sandwich of electrolyte, titanium oxide and dye to create electric current.
- DSC production is based on screen printing equipment rather than vacuum systems and does not require silicon.

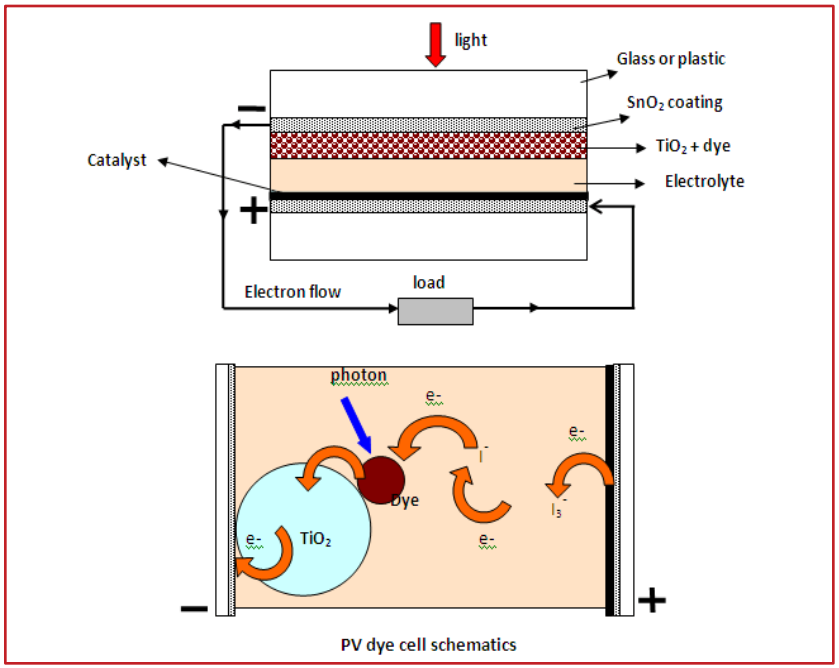


DSC TECHNOLOGY

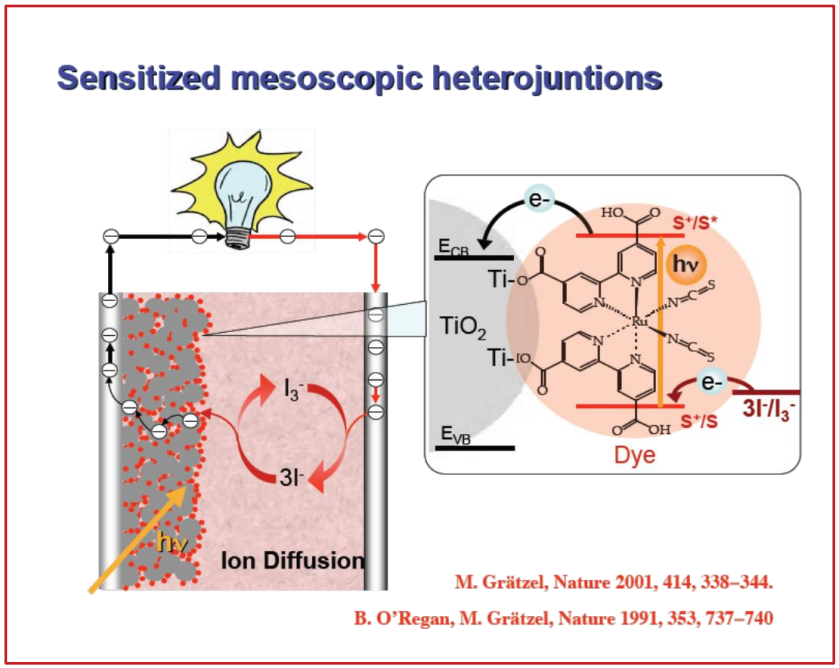
EXTENSIVE USE OF NANOMATERIALS

Light striking the dye excites electrons which are collected by titania to become electric current. DSC is printed photovoltaics.

With no efficient method to extract current from the cell, the technology remained in the lab – **until now**.



PV dye cell schematics



M. Grätzel, Nature 2001, 414, 338–344.

B. O'Regan, M. Grätzel, Nature 1991, 353, 737–740

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ACHIEVEMENTS

WORLD RECORD 3GSOLAR DYE CELLS

- Our special design **increases active cell area, efficiency and durability**.
- **World record** size and currents for DSC:
  - 15x15 cm glass cells– same size as commercial silicon cells
  - Cell current Isc of 3A under one sun
- Small glass cells - 10.1% efficiency
  Large glass cells - 7.2% efficiency
  Small plastic cells - 5.9% efficiency
- 3GSolar now working with a **unique innovation** of multiple dyes, increasing cell efficiency & maintaining low cost

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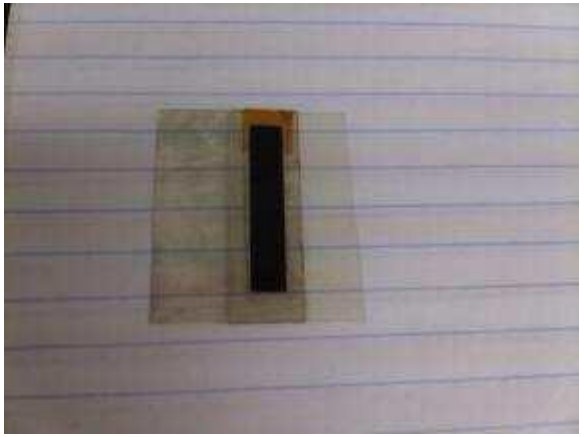
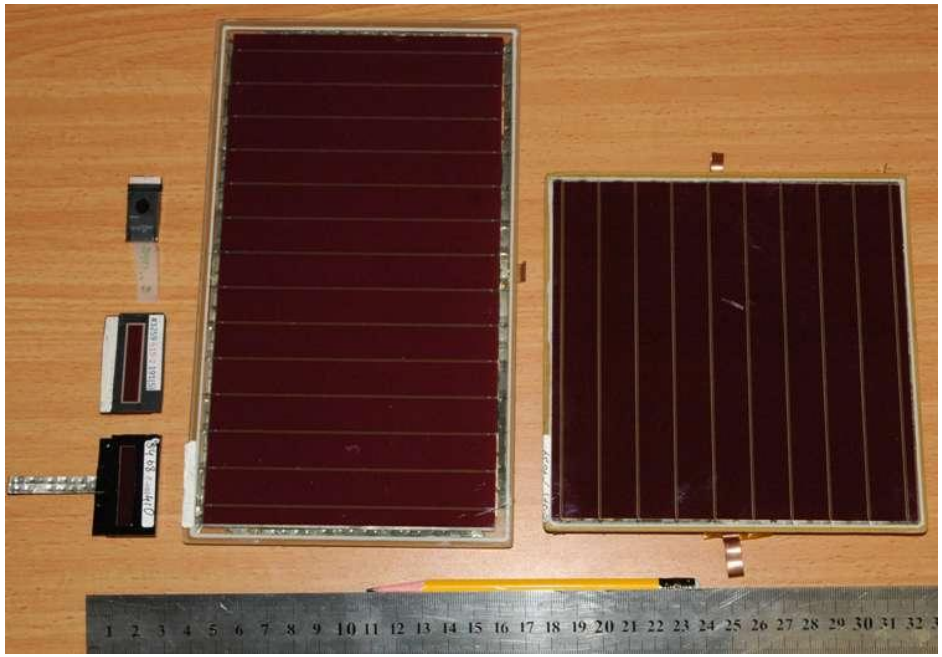
3GSOLAR GLASS CELL AND PLASTIC CELL DESIGN

BOTTOM LEFT- GLASS CELLS SMALL AND LARGE
TOP RIGHT – ALL PLASTIC CELL





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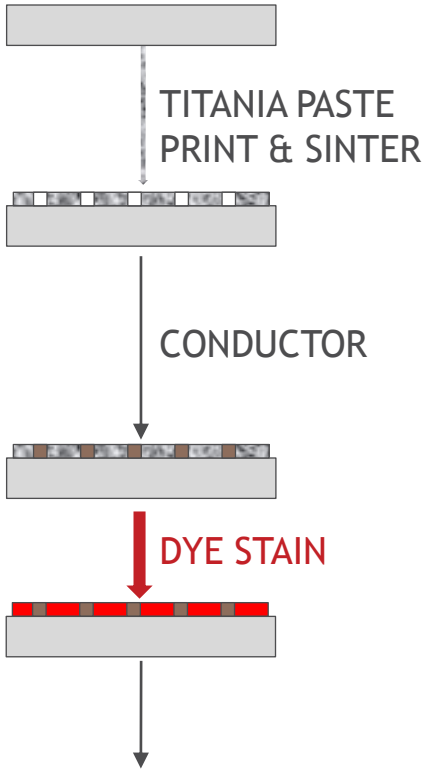
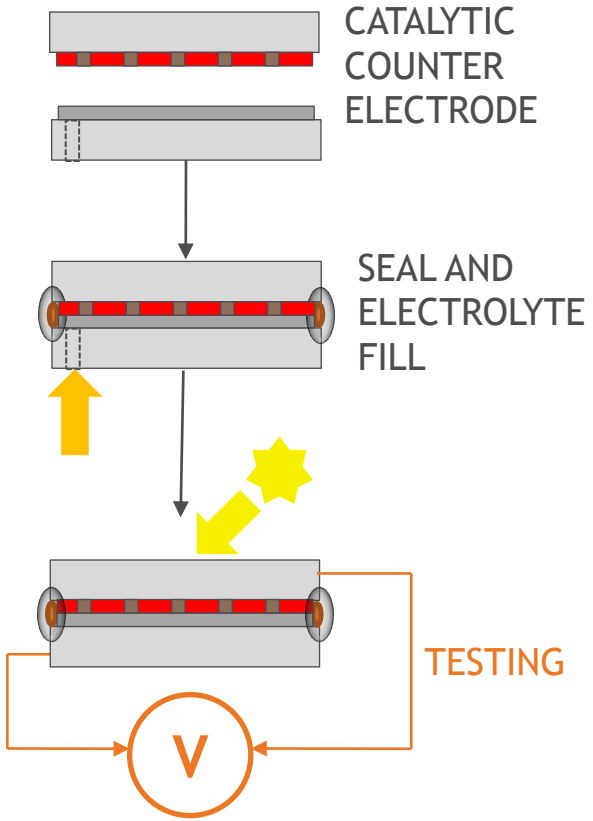
3GSOLAR PHOTOVOLTAICS – GLASS CELL MANUFACTURING

SCREEN PRINTER

BELT FURNACE

CONDUCTING GLASS





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3GSOLAR COMPARATIVE ADVANTAGES
WITH EXISTING PV TECHNOLOGIES

- DSC production is based on **screen printing** equipment rather than expensive vacuum production processes.

- Dye materials can be synthesized by industry in large quantities with no limits.

- **Effective in poor light conditions** – earlier and later times of the day, cloudy conditions, high latitude geographical locations, non-optimum module orientation.
  - More kilowat hours per kW of modules

- **Robust performance** with dirty modules and when shaded by surroundings. The electrochemistry of 3GSolar DSC creates inherent diode protection of each cell.

- DSC creates PV modules with **different colors meeting aesthetic and architectural needs**.

3GSOLAR DEVELOPMENT TARGETS

BOTH IN GLASS AND PLASTIC CELLS

10% efficiency of printed commercial glass power and BIPV modules in 2015

15% efficiency of printed commercial glass power modules in 2019 – meeting cost goal of 35 cents/peak watt

25 year durability of printed glass modules (retain 80% efficiency)

Commercial-quality large area flexible modules by 2015

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DSC SALES TRENDS

SUMMARIZING NANOMARKETS PROJECTIONS FOR DSC

Portable charging applications are the main market for DSC in 2012 and 2013

The main DSC market shifts to BIPV in 2014 due to many advantages of DSC over silicon in this market

Third largest DSC market is DSC for embedded devices.* Market continuously grows from 2012 through 2019

Power module sales for utility scale and rooftop begin 2015, competing on market price with silicon

*Embedded means a solar cell fully integrated with devices for healthcare, consumer, wireless, sensors and others.

THANK YOU

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