Innovative Thin Films, LLC
Toledo, OH 43606

Founded 2002

Dr. Dean M. Giolando

Alan McMaster

Equity Partners 2008

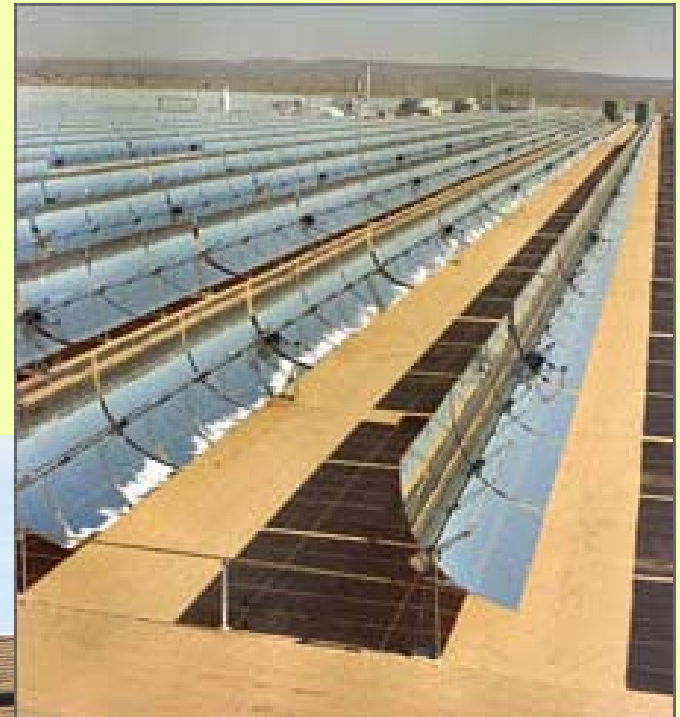
Dr. Norman Johnston- Solar Fields, USA

Peter Gerhardinger- IPD

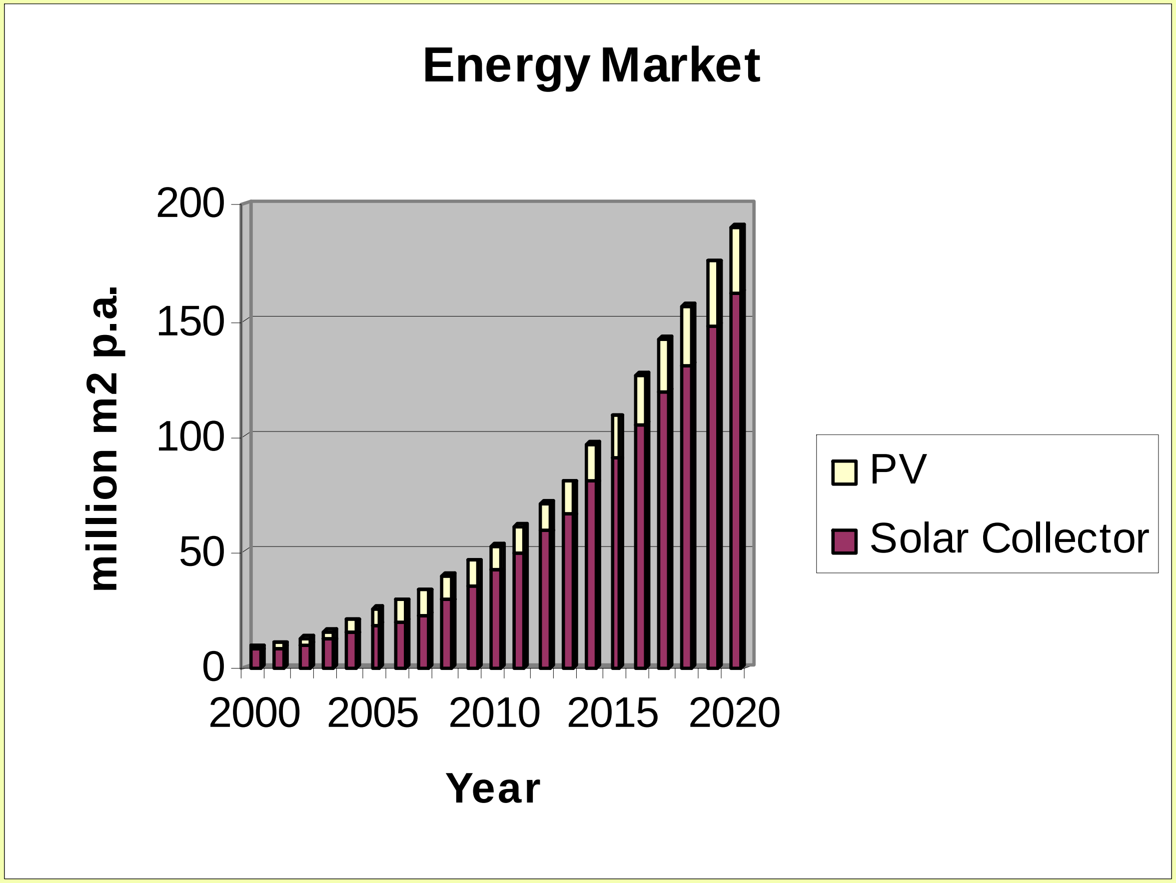
Dr. Norman Rapino- IPD

Motivation

Solar Energy Resources



Solar Energy Market

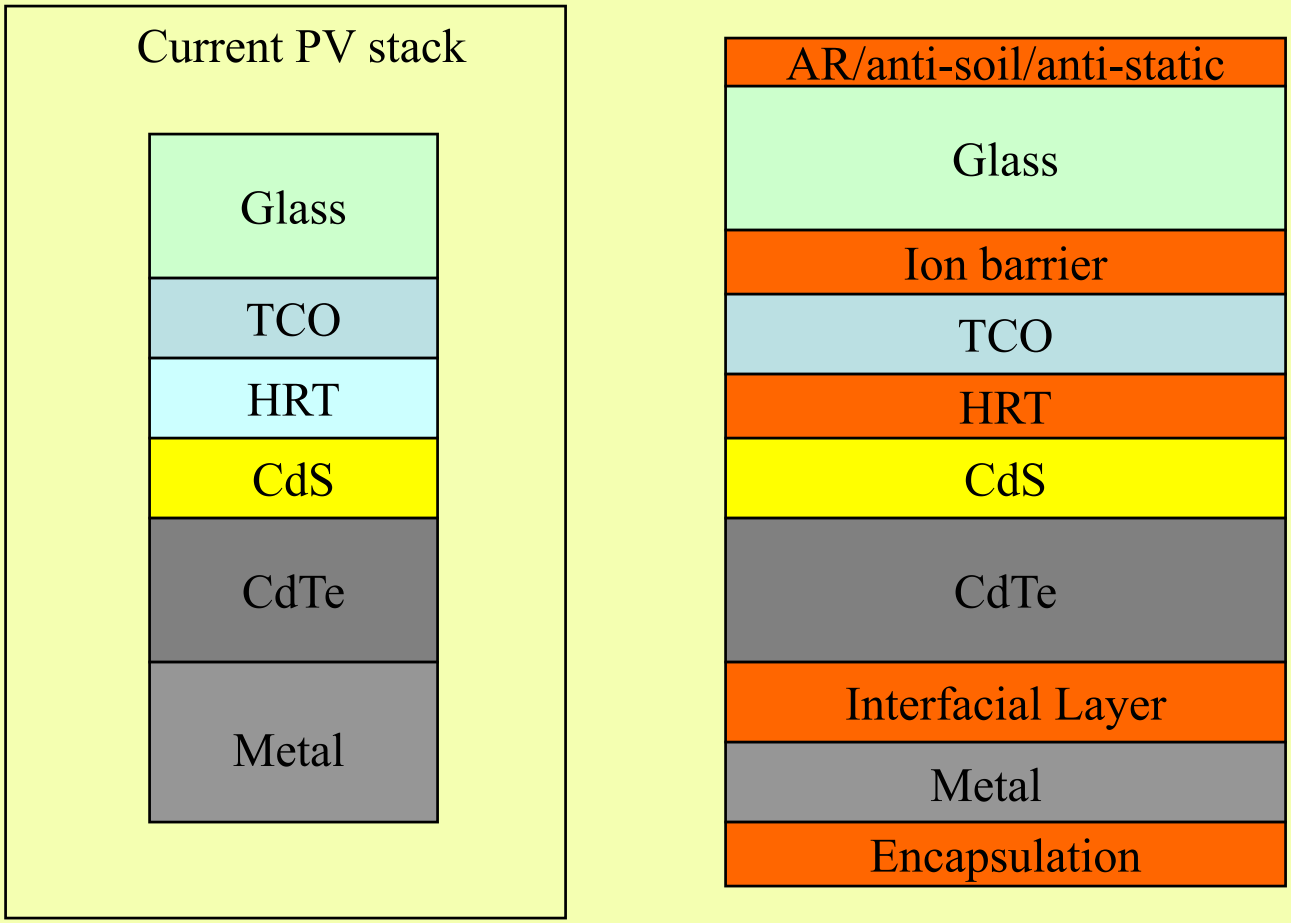


10 Float Lines by 2020

Dr. Matthias Fawer-Wasser, Sarasin Basic Report**,** Current status and outlook for photovoltaics and solar thermal power, **"**Solar energy – sunny days ahead?", November 2004.

ITF Technology

Photovoltaic Thin Film Stack



Transparent ceramic, with nano-scaled photocatalyst;
Al_2O_3/n-TiO_2
SnO_2/n-TiO_2

Transparent ceramic;
Al_2O_3

Transparent ceramic;
SnO_2:Ti

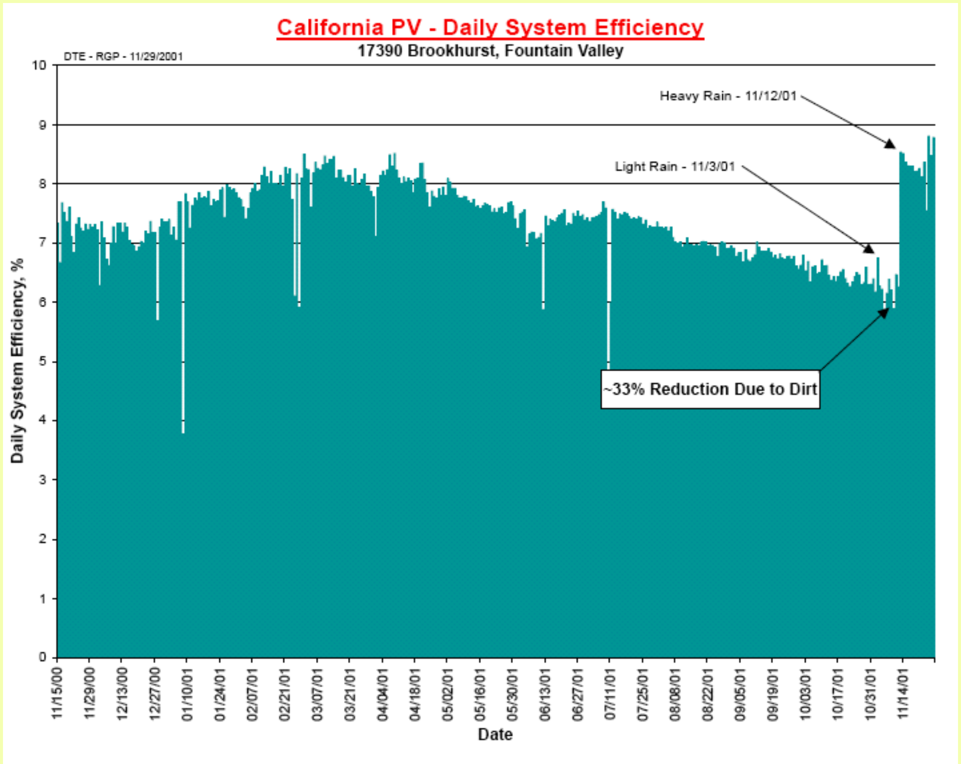
Ceramic, with nano-scaled metal particles;
ZrO_2/TiC

Low temperature ceramic;
ZrO_2

Field data obtained from Ryan Waddington of DTE.

System	Rated Power 2/01 in kW	Measured Power Before Cleaning in kW	Measured Power After Cleaning in kW	Power Loss Before Cleaning in %
Carlsbad	100.5	81.7	97.4	16.1*
Fountain Valley 1	116.4	81.8	112.0	27.0*
Fountain Valley 2	109.1	79.4	108.7	27.0*

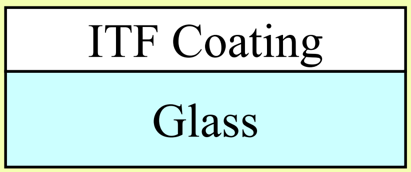
* Based on Ņbefore cleaningÓ(9/22-26/04) and Ņafter cleaningÓ(C, 10/04/04; FV 1 and 2, 9/28-29/04) measurements.

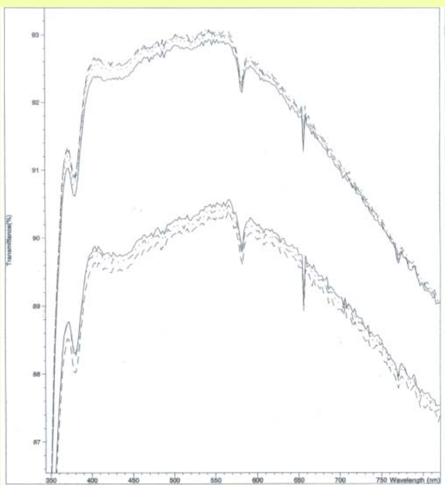


Soiling Cost Analysis for a 30 MWh PV Array

Irradiance ($kWh/m^2/day$)	5	5	5
Efficiency (%)	10	10	15
Energy Rate ($/kWh)	0.11	0.20	0.11
Array size (m^2)	300,000	300,000	200,000
Net loss to soiling (%)	4	4	4
Array revenue ($/20yr)	120,450,000	219,000,000	180,675,000
Revenue soiling losses ($/20yr)	4,818,000	13,140,000	7,227,000
Anti-soiling coating ($\$/m^2$)	2.10	2.10	2.10
Anti-soiling cost ($)	630,000	630,000	420,000
Payback (yrs)	3	1	1
Anti-soiling profit ($/20yr)	4,188,000	12,510,000	6,597,000

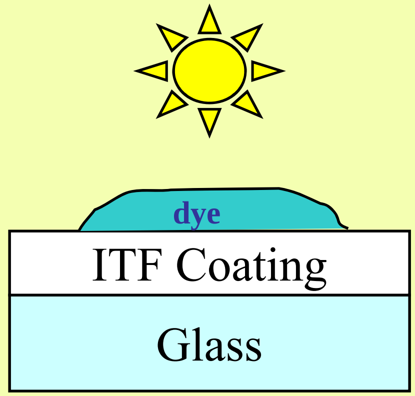
Solution: Stop Soiling in the Field (common to PV, solar thermal and concentrators)

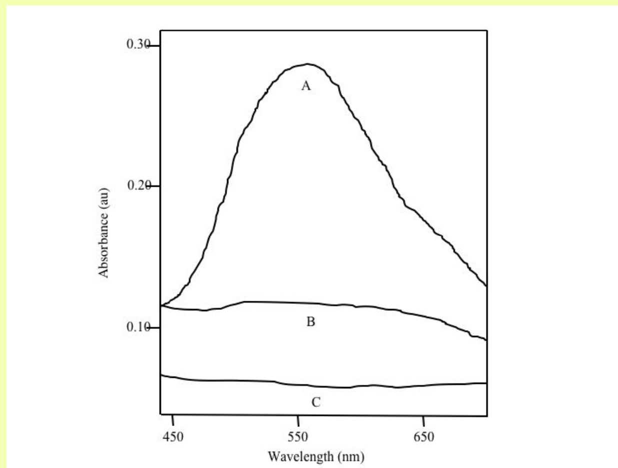




%T spectra:

Glass, 90 %
Coating/glass, 93 %



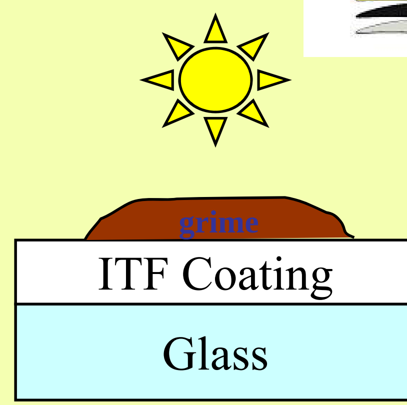


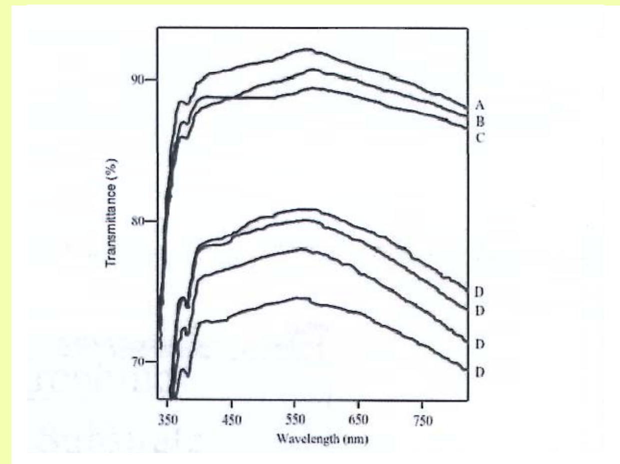
Absorbance of dye:

A) Before exposure to light

B) After 16 h exposed to light

C) Background, coated glass



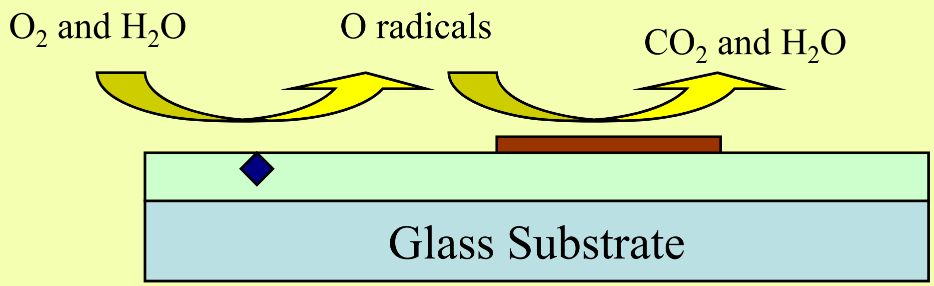


Field Test (two months outdoors):

A) Cleaned ITF coating
B) "Soiled" ITF coating
C) Cleaned glass
D) "Soiled" glass

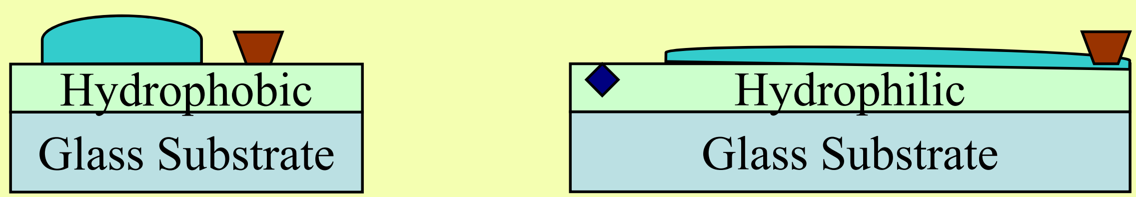
How does the “self-cleaning” coating work?

A) Photocatalyst degrades organic matter



B) Photocatalyst provides a hydrophilic surface

- sheening water pushes solids to edge



C) Conducting coating provides an anti-static surface

- repels electrostatically bound particles

How much coating activity is needed?

A) Most researchers work for 100 %

- efforts to increase photo-activity
- efforts to obtain “super hydrophilicity”
- highly variable results
  - Commercial samples show varying properties

B) But high activity may not be necessary

- lower levels of photo-activity *keep surfaces cleaner*
  - reducing soiling losses from 12 % to 3-4 % is profitable
  - **best test** = place sample outdoors for two weeks

* Point: bring more sunlight to photoabsorber

Testing of self-cleaning coatings

A) Degrading organic dots

- Wash sample, dry with air knife
  - water beads up (large contact angle)
- dry at 50 °C for three hours
- place under UV lamp for six hours
- apply organic test sample (steric acid or methylene blue)
  - water sheens (low contact angle)
- cover 1/2 of organic with glass plate (UV filter)
- expose to UV light for 16 hours
  - be certain there is a gentle air flow (floor of chemical hood)
  - be certain there is at least 1 cm distance
  - do not breath on sample

B) Outdoor testing

- place sample (coated and uncoated glass) in sunny place
  - near trees, airport, cars, …
- leave for two weeks or longer, incline circa 40°
- measure %T (do not use eye, dust is present) of coated and uncoated glass

ITF Technology (Third Frontier-Wright Capital Project)

Spray on cold, then heat to high temperature

Glass seamer → Washer → ITF Sprayer → Temper → Quench → Cooler

FLOW →

Spray on while substrate is hot, 350 to 450 °C

Glass seamer → Washer → Temper → Quench → ITF Sprayer → Cooler

FLOW →

ITF Product Description

Novel Process Equipment

- Benefits:
  - High throughput >5 m/min
  - Low operating cost
  - Low capital cost < $300k
  - Continuous process
  - 60 cm web (expandable to 120 cm)
  - Atmospheric pressure deposition process
  - Single process for multiple films with multiple applications

* Coating applied in one pass

Coatings applied onto exposed surfaces in the field

- Alternate business plan:
  - deposit self-cleaning coatings on installed devices

Cost moved to energy point-of-use customer

  - solution is washed on near room temperature,
    then wipe off excess solution.

    - $SnCl_4/NH_4[HF_2]/TiO_2$ in water

high photoactivity, but not conducting

can apply on AR coated substrate

can apply on conducting substrate

durability is unknown, but can be heated to 600 °C

* Wash cover plate, coat, air knife off excess, pass through tempering?

ITF Products

- License thin film atmospheric pressure process equipment and chemical systems
- Build and sell equipment, license IP
- License solar energy thin films
- ITF has patents pending for process equipment, chemical systems and coated solar energy devices

ITF Development

- ITF films reduce the impact of reflective and soiling losses
  - Atmospheric deposition equipment
  - Developed films for solar energy devices
  - Anti-soiling coatings
    - damp heat; boiled in water and saline for 1 month
    - ASTM D1308; chemical exposure
    - ASTM G154; UV light exposure
    - SEM analysis
    - depth profile
    - scratch resistance (via crystals of known hardness)
- Interactions with PVIC, testing
  - Durability
  - Weathering
  - Surface hardness
  - Light Soak
  - Microscopy (SEM and TEM)

Summary

- Simple technology
- Advantages over competition
- Low capital cost for market entry
- Rapidly growing market
- IP on technology