The Power of Light

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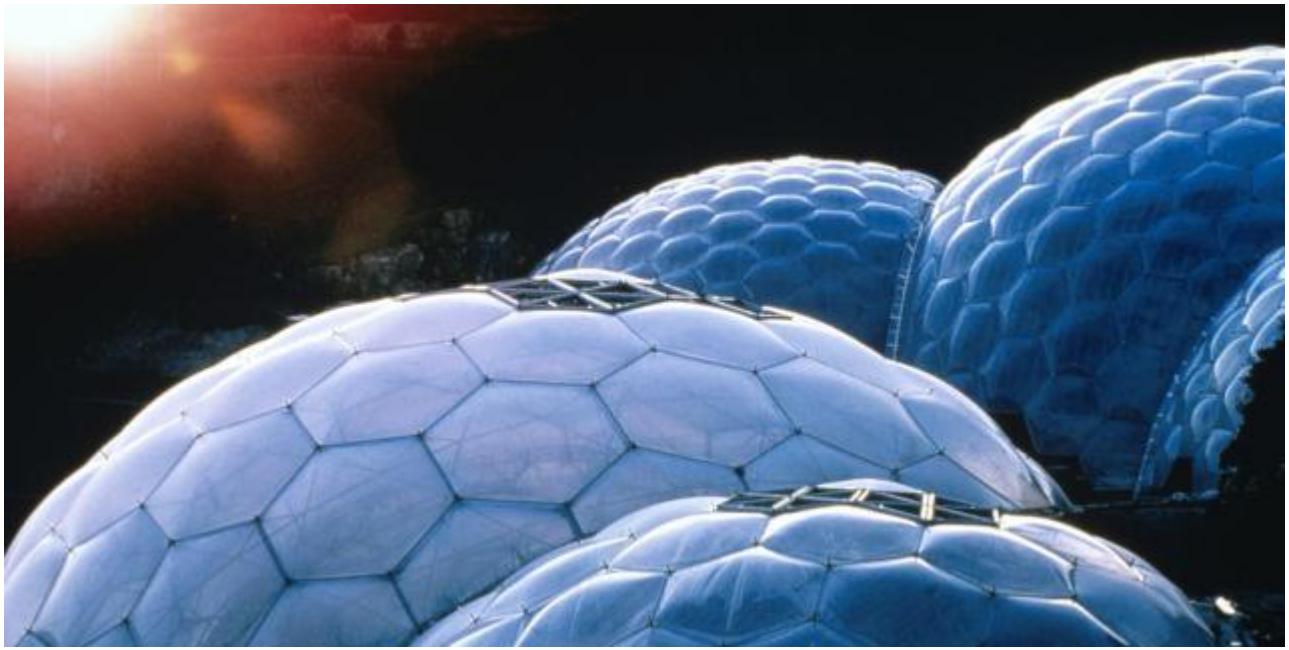
http://people.bath.ac.uk/pysabw/

Solar power is popular

www.bbc.co.uk 21.04.15

The Energy Tree
Millennium Square, Bristol,
April 2015

Eden Project



http://www.edenproject.com

30 kW from panels on the roof of the Core, the education building

Mootel Glastonbury,

200 kW from a cowshed

Congresbury Solar Farm

© Bristol Post 16 April 2014

36 MWatt of power
Operate over 25 years

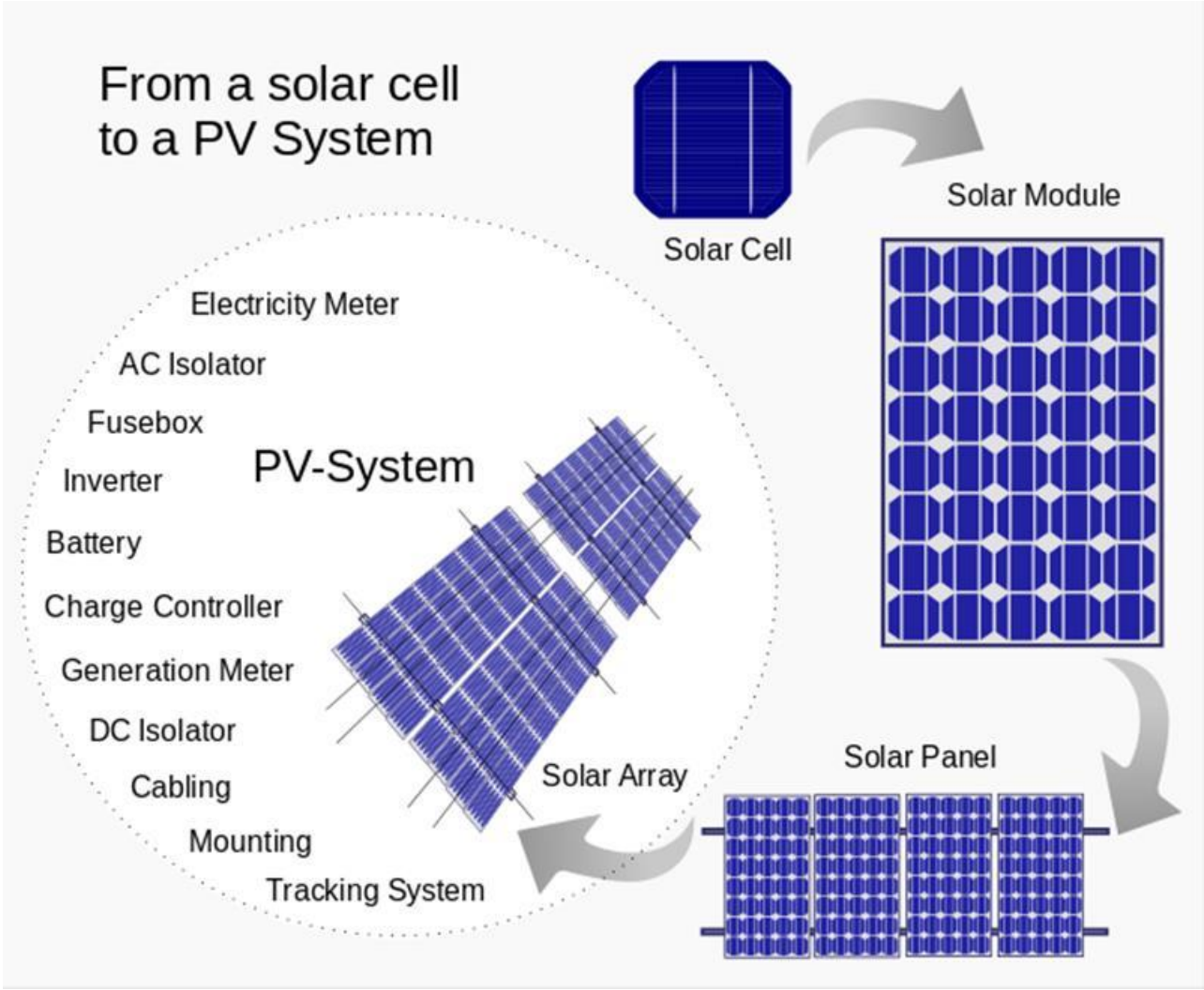
Chancellors' Building

200 modules
42 MWatt of power
50 kWp
£5000 savings on power bill
£5000 feed in tariff

An introduction to solar power

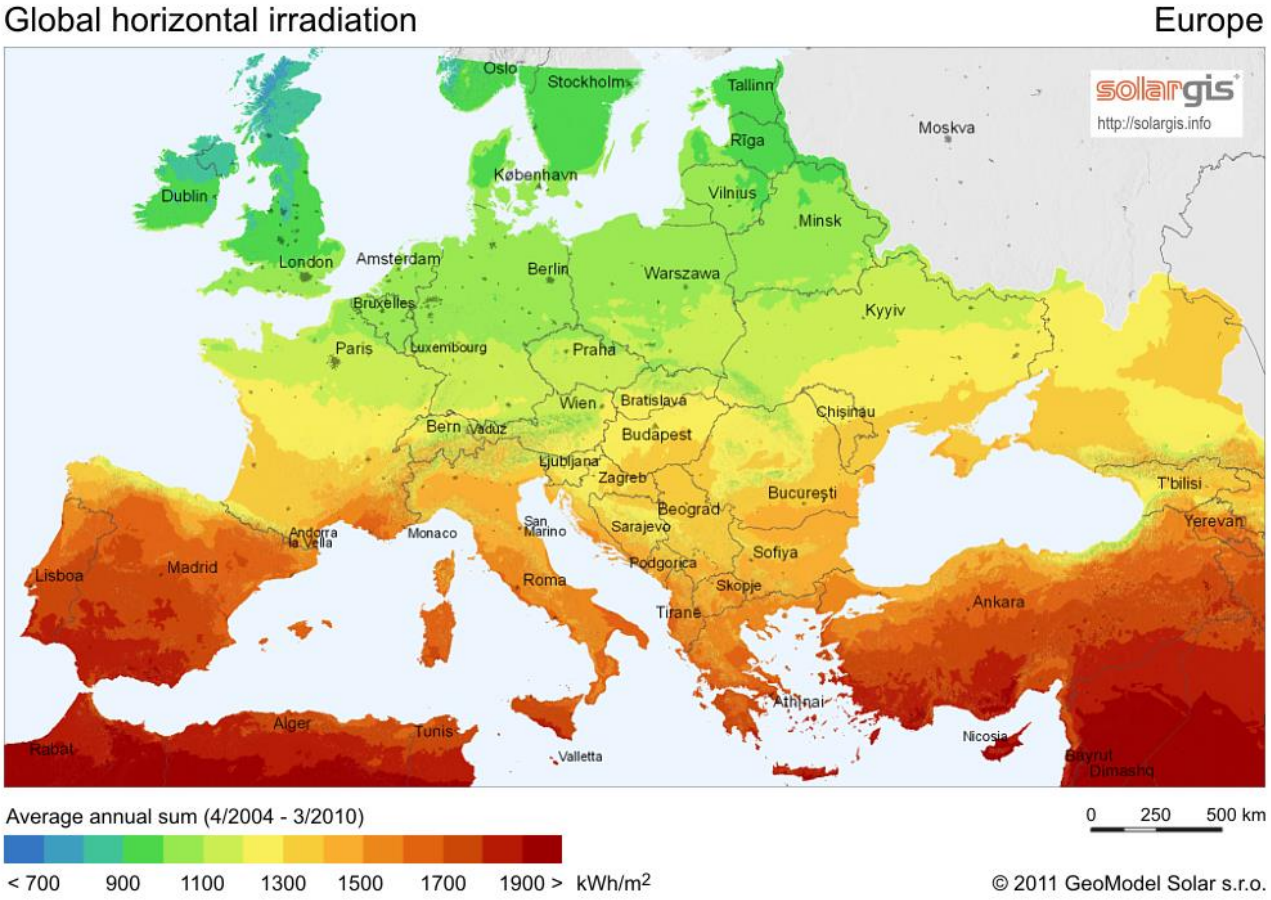
- What happens to the sunlight?
- Does it matter where you live?
- Price crash for silicon solar cells
- New solar cell technologies
  Why?
  How?

What happens to the sunlight?



Wikimedia Commons

Does it matter where you live?



SolarGIS © 2014GeoModel Solar

Price crash for silicon solar cells

Mono-crystalline silicon

en.wikipedia.org

Poly-crystalline silicon

MIT Open CourseWare

Silicon solar cells need to be angled correctly

CDT-PV postgraduate students looking into solar power for Bath Abbey

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Bath Abbey Footprint
http://www.bathabbey.org/footprint

Concentrators

Parabolic Mirror Array

500 suns

25 kWatt output

New solar cell technologies Why?

Semitransparent Photovoltaic Glass

www.onyxsolar.com/

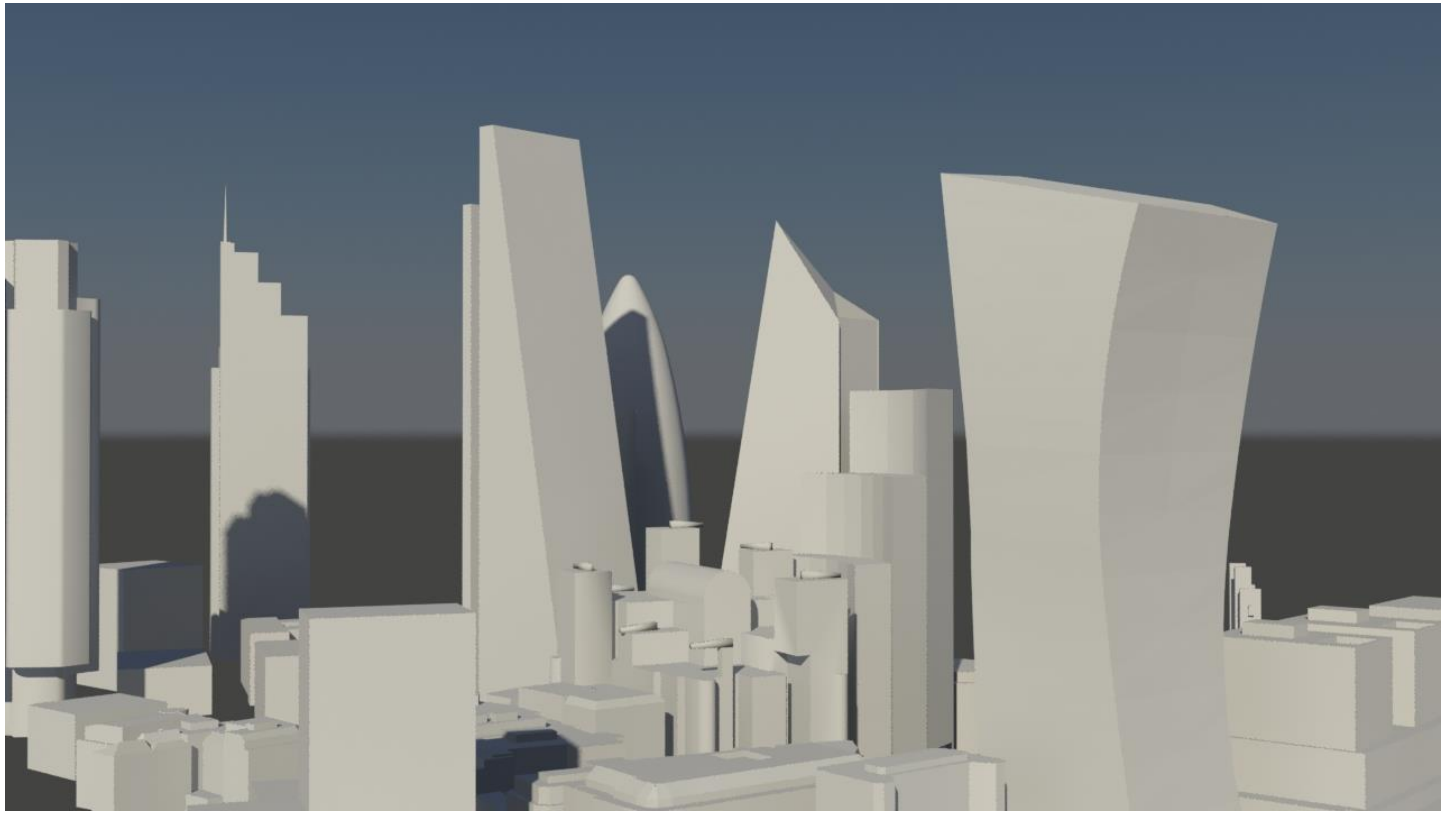
Building Integrated Photovoltaics

en.wikipedia.org

Neil Cummings Flickr

Your Rainbow Panorama, Ólafur Elíasson, ARoS Kunstmuseum, Aarhus 2013

Three quarters of the total US electricity demand was consumed in the building sector. Almost 30% is consumed for lighting, around 25% by appliances, around 25% for space cooling and refrigeration, and the remainder is for other uses such as water heating, ventilation... IRENA, Renewable Energy Prospects for the USA (2015)



http://www.oxfordpv.com/Case-Studies

Energy generation and savings (per annum)

- Building consumption: 1,610 MWh/yr Note 2
- Oxford PV energy generation: 944 MWh/yr
- Saving as percentage: 60%

Off grid applications

Azuri Ltd solar lamp

http://www.azuri-technologies.com
/info-hub/lighting

A History of the World in 100 Objects

British Museum director Neil MacGregor

Portable solar cells integrated with batteries and LEDs could replace kerosene lamps.

Uses

Image from designboom ©2015 courtesy of EIGHT

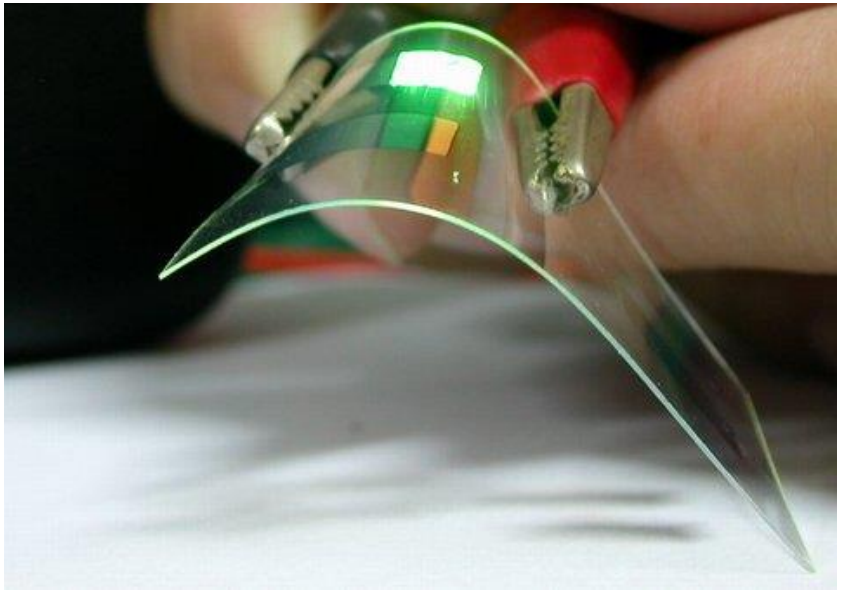
Solar powered charging station

Bus shelters
Cars
Sensors
Packaging

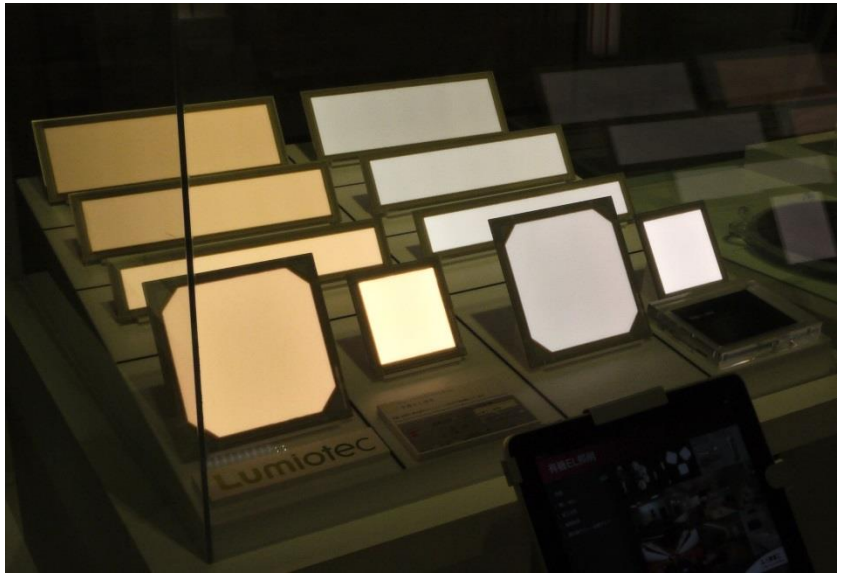
Organic Light Emitting Diodes: The future of light bulbs could be no light bulbs at all

A B Walker: Article to appear in THE CONVERSATION

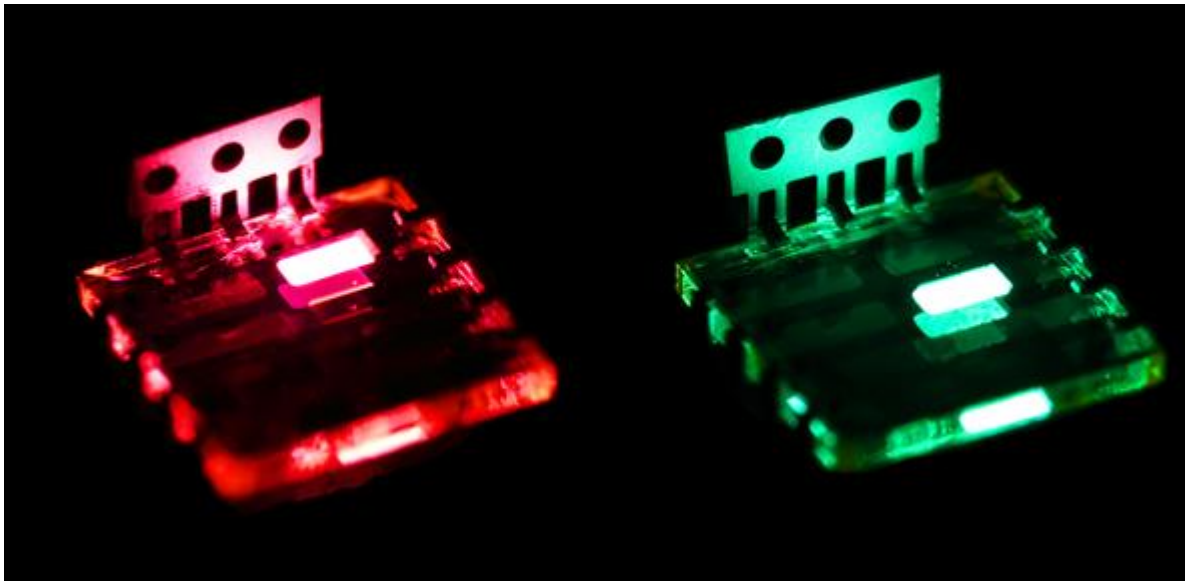
OLED panel
meharris



Prototype OLED
lighting panels
STRONGlk7



Perovskite OLEDs



http://phys.org/news/2014-08-material-perovskite.html

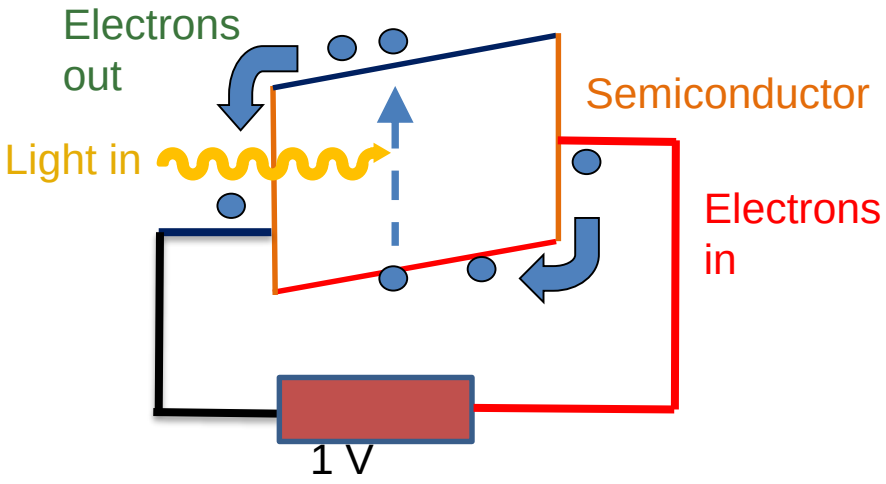
OLED Wall Living Shades Trendforum 012

Grand societal challenges answered by OLED lighting

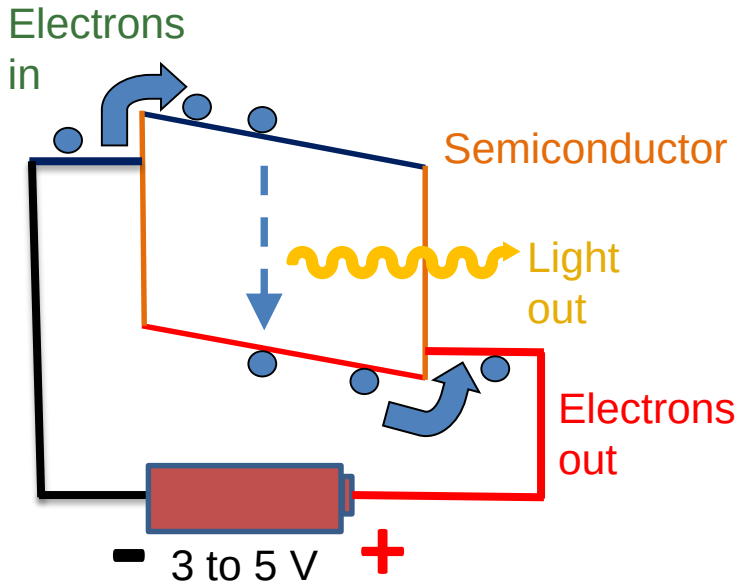
- Climate action by energy savings in buildings with OLED lighting.
  Organic devices have low embedded energy
- Environment: OLED lighting contains no mercury, eliminating the disposal and pollution problems associated with fluorescent lighting.
- Resource efficiency through additive manufacturing methods such as printing on flexible substrates, leading to reduced wastage.
- Local manufacture leads to reduced environmental impact from the distribution /transport network of complete goods.
- Raw materials usage: these materials are abundant and disposable

New solar cell and LED technologies
How?

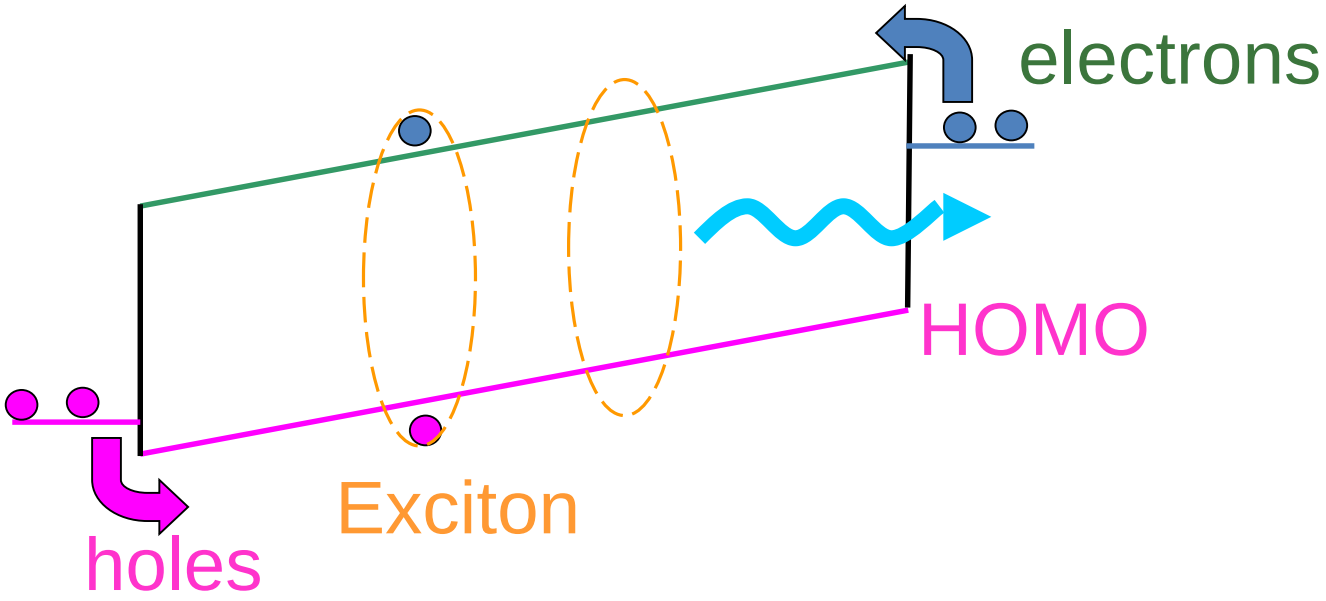
Solar Cell



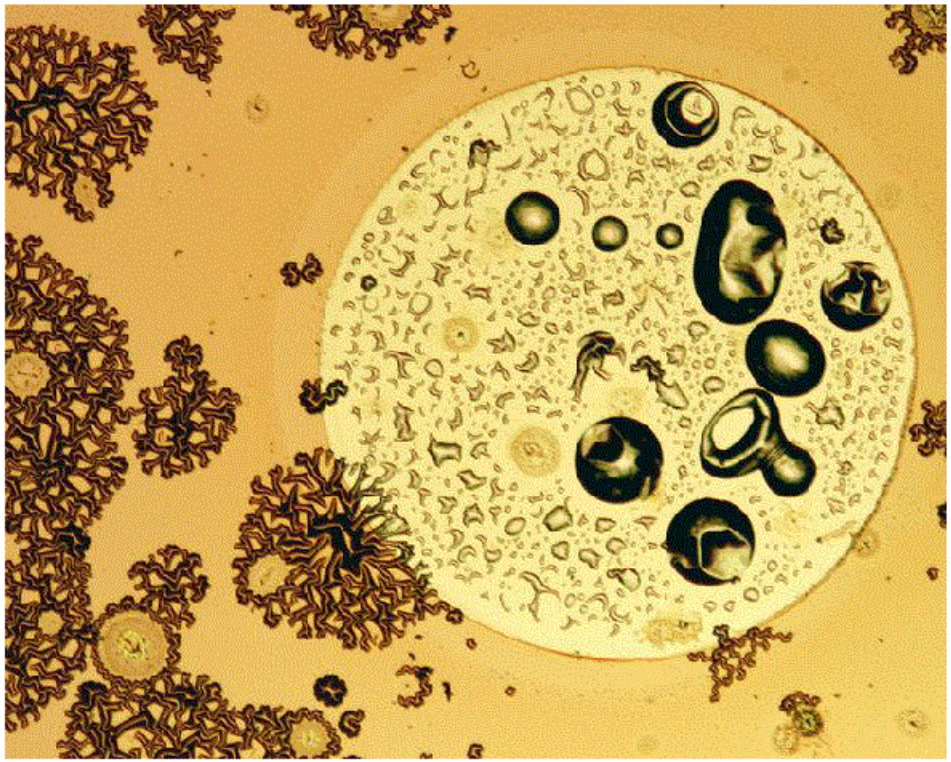
LED



Organic solar cells are more complicated…



Thin Film solar cell



Eren Ore, University of Cambridge

A thin film device is typically processed by depositing multiple layers of thin films, each having nanometer scale thickness. On some occasions they start to delaminate.

CIGS: Copper Indium Gallium Selenide Solar Cells

Picture taken by Dantor

CIGS cell on a flexible plastic backing.

☺ efficiency – 20%
☹ Difficult to make thin films
☹ Loss of some of the elements
☹ Indium and Gallium rare and expensive
☹ Business hard to sustain – may be undercut

CdTe solar cells

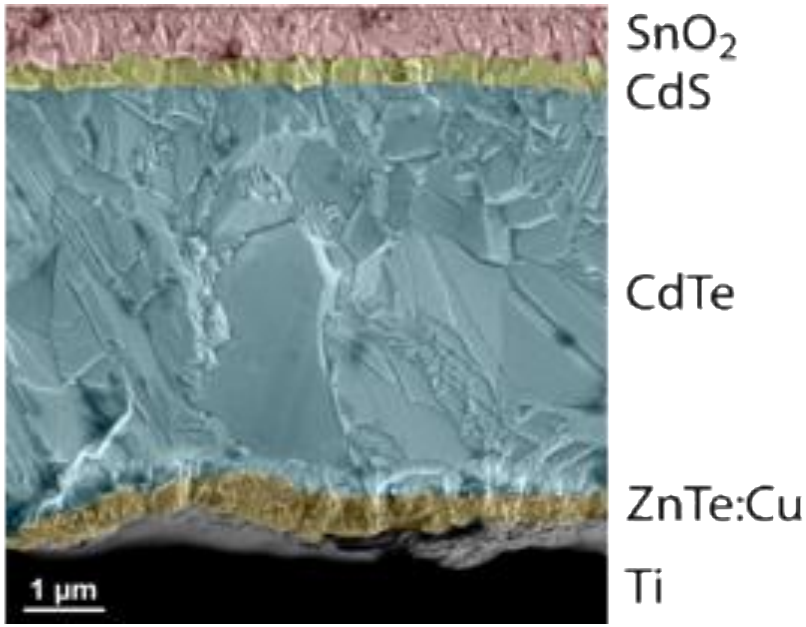


Image from Rommel Noufi

☺ Easy to produce

☺ Cheapest solar cells

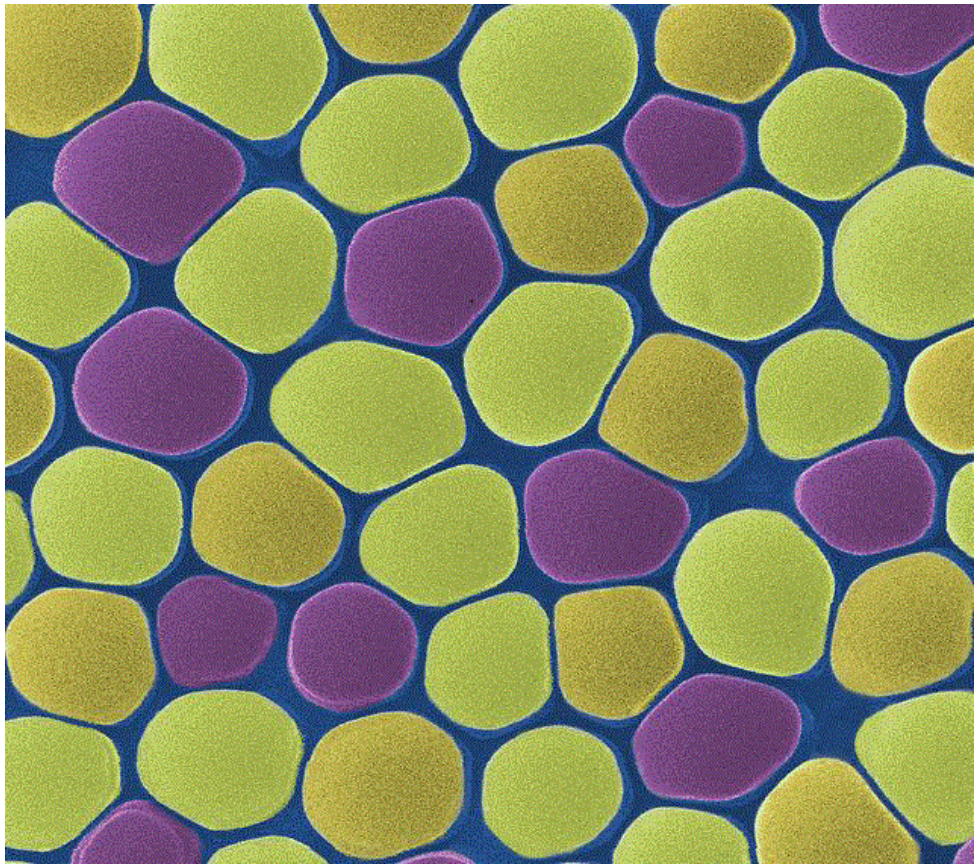
☺ Main competitor to silicon

☺ Efficiency gain 16% - 20%

☹ Cd is toxic

☹ Te is scarce

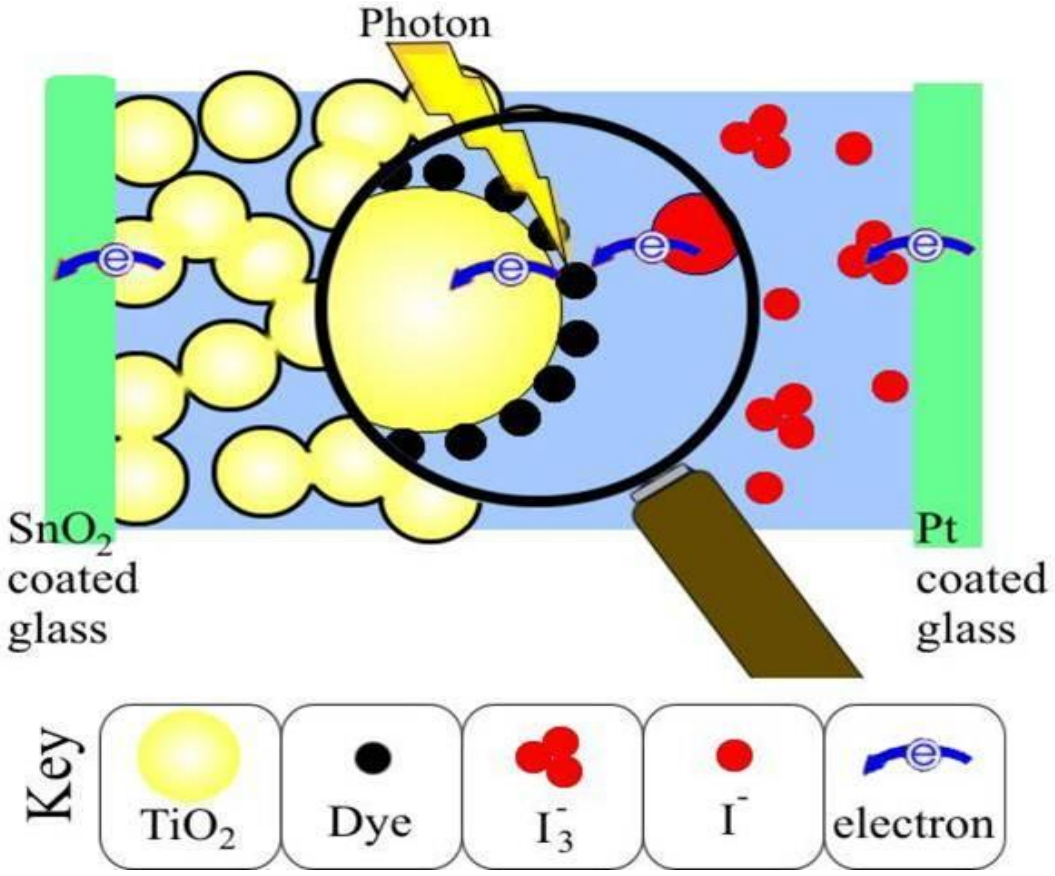
Dye-sensitized solar cell



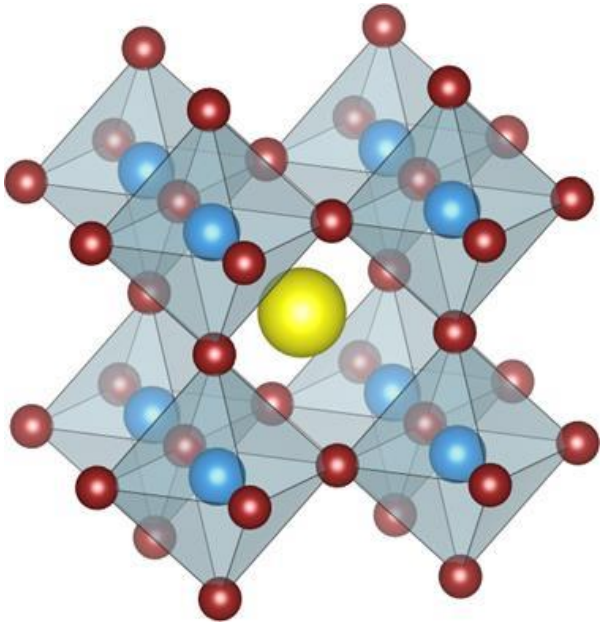
Pacific Northwest National Laboratory

Array of Titanium Dioxide Nanotubes: these are coated with dye that absorbs the light and then generates charges

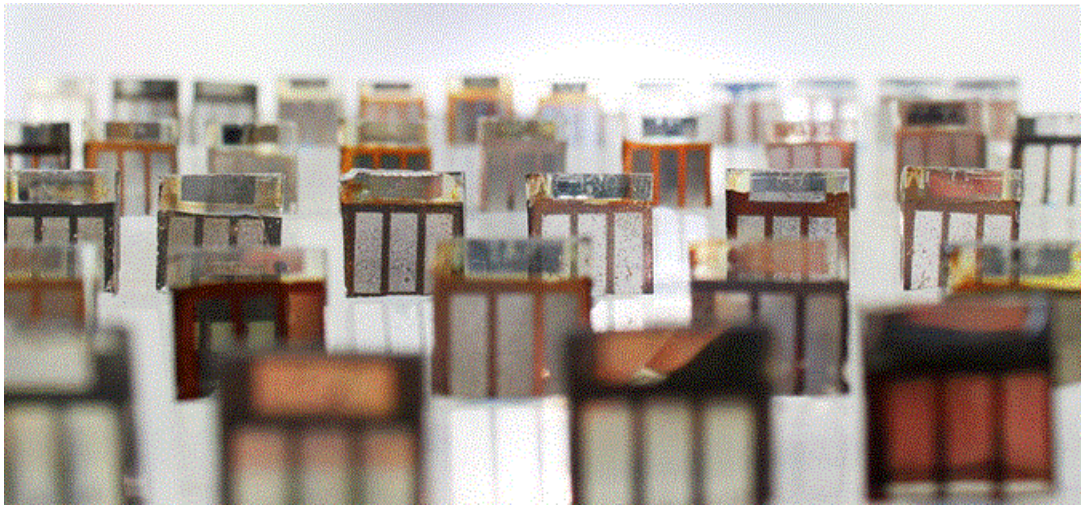
How dye-sensitized cells work



Perovskite solar cells



Federico Brivio, Destiny Project



Matt Carnie Swansea

Perovskite structure

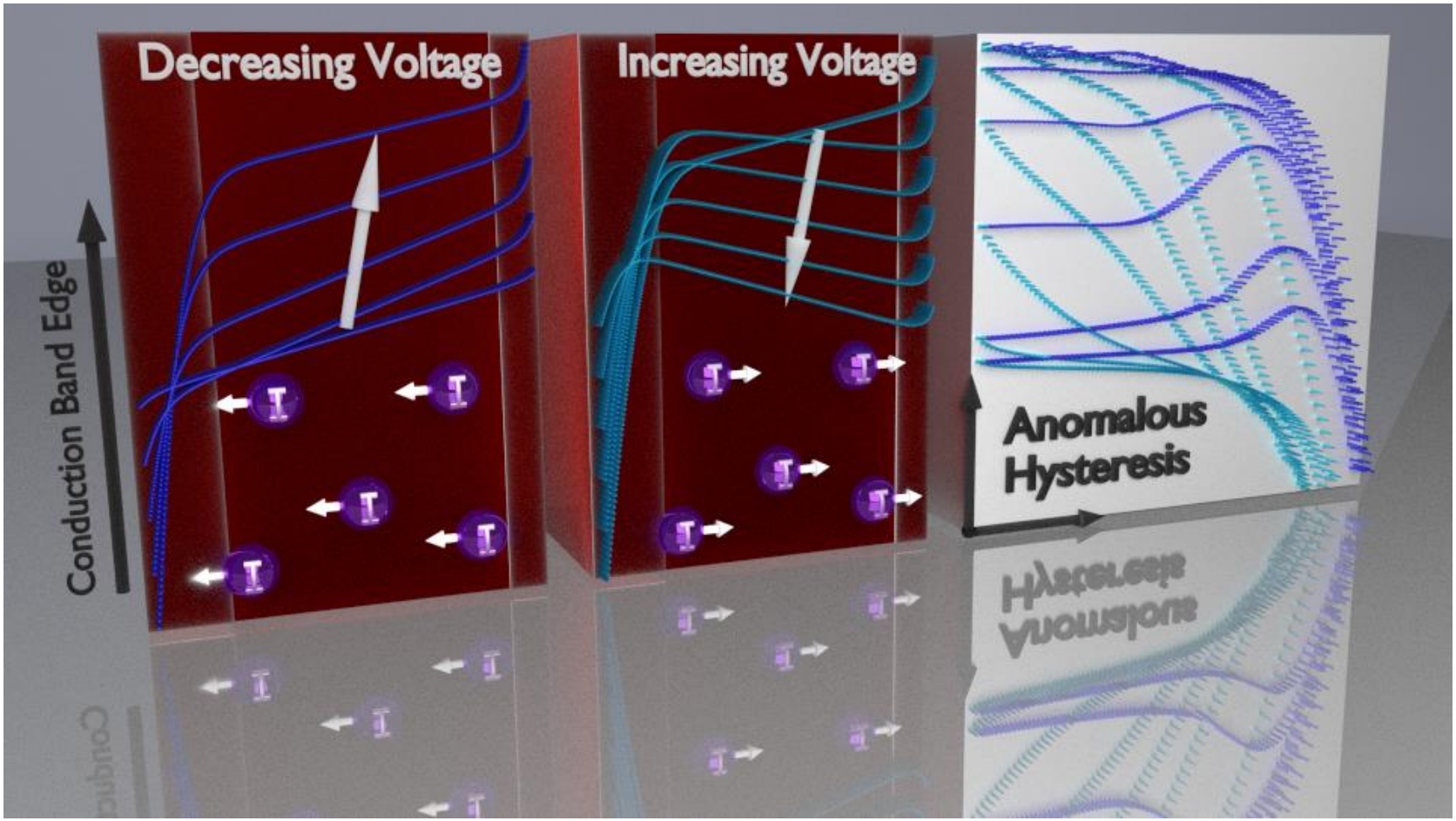
- Methyl Ammonium
- Negative Iodide ion
- Positive Lead ion

Graveyard of ambition or cradle of ambition?

DESTINY

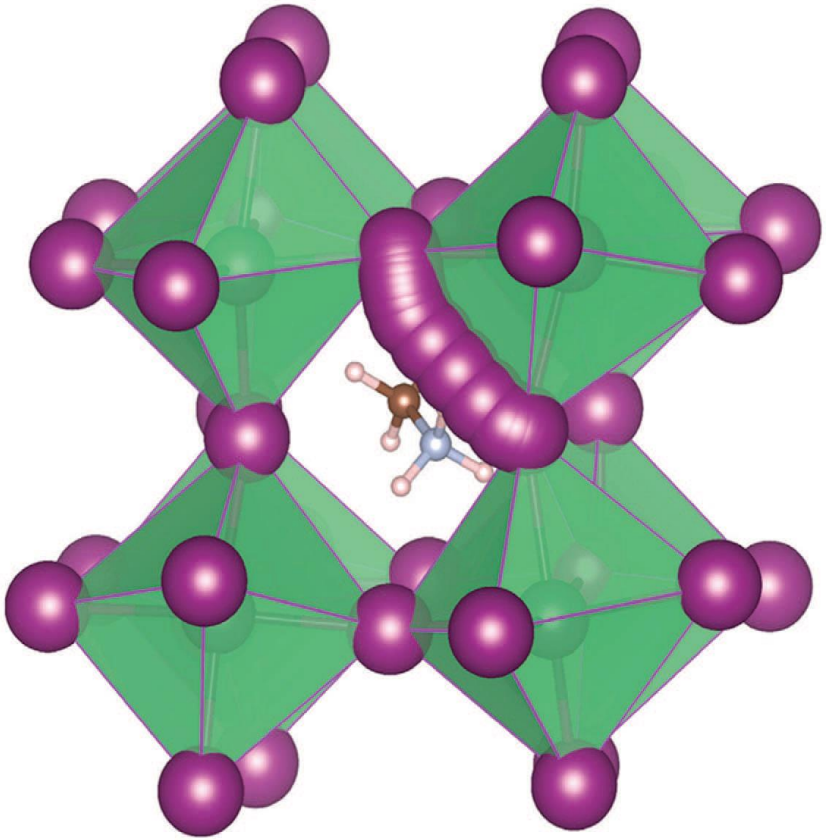
DyE SensiTIzed solar cells with eNhanced stabilitY

Perovskite cell performance depends on its history



G Richardson, S E J O'Kane, R G Niemann, T A Peltola, J M Foster, P J Cameron, A B Walker
Energy & Env Sci **9** 1476 (2016)

Iodide vacancy migration path



C Eames, J M Frost, A Walsh, P R F Barnes, B C O'Regan, A Walsh, S Islam Nature Comms **6** 7497 (2015)

Plastic solar cells

Eight19

Heliatek

☺ Have potential for low cost

☹ Unstable – molecules can be damaged by solar radiation

☹ Low efficiency

☹ Companies can’t make it pay

Looking inside a plastic solar cell

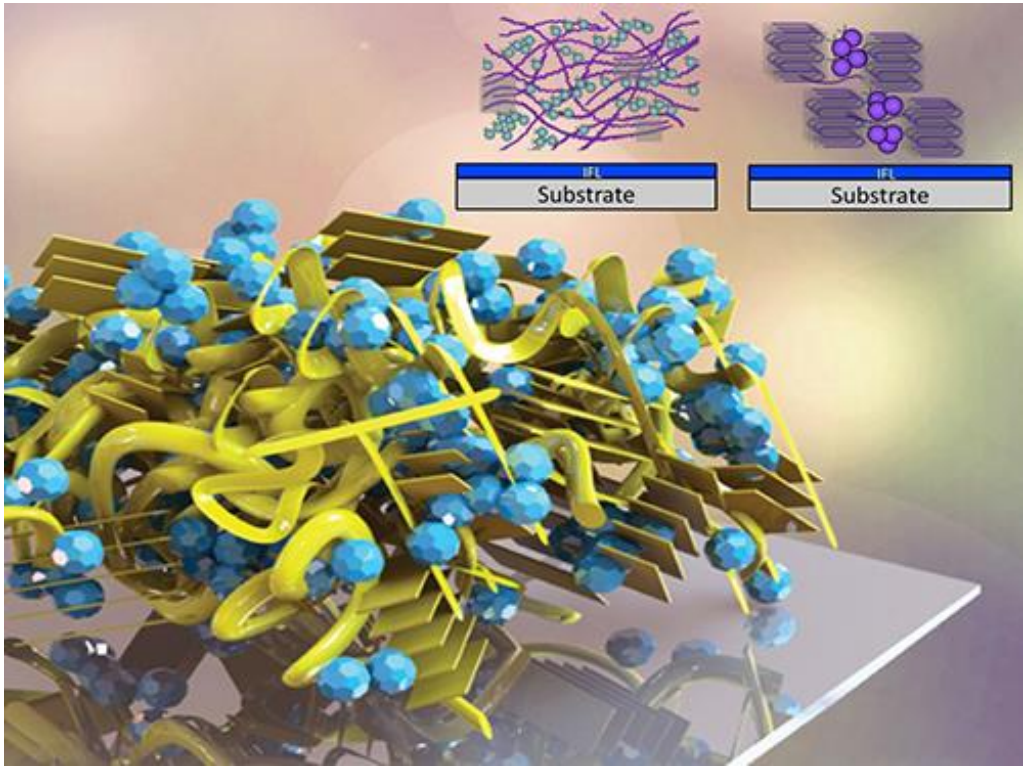


Image by Jenny Morber and Lin X. Chen based on J.M. Szarko et al., Adv. Funct. Mater. **24**, 10 (2014).

Fullerene molecule

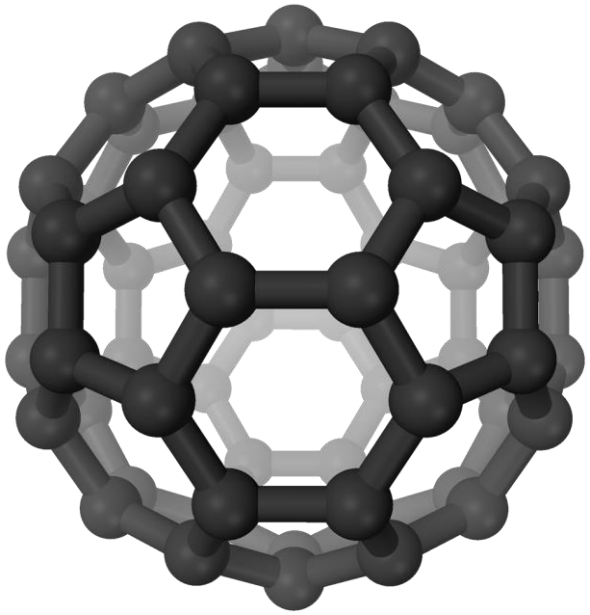
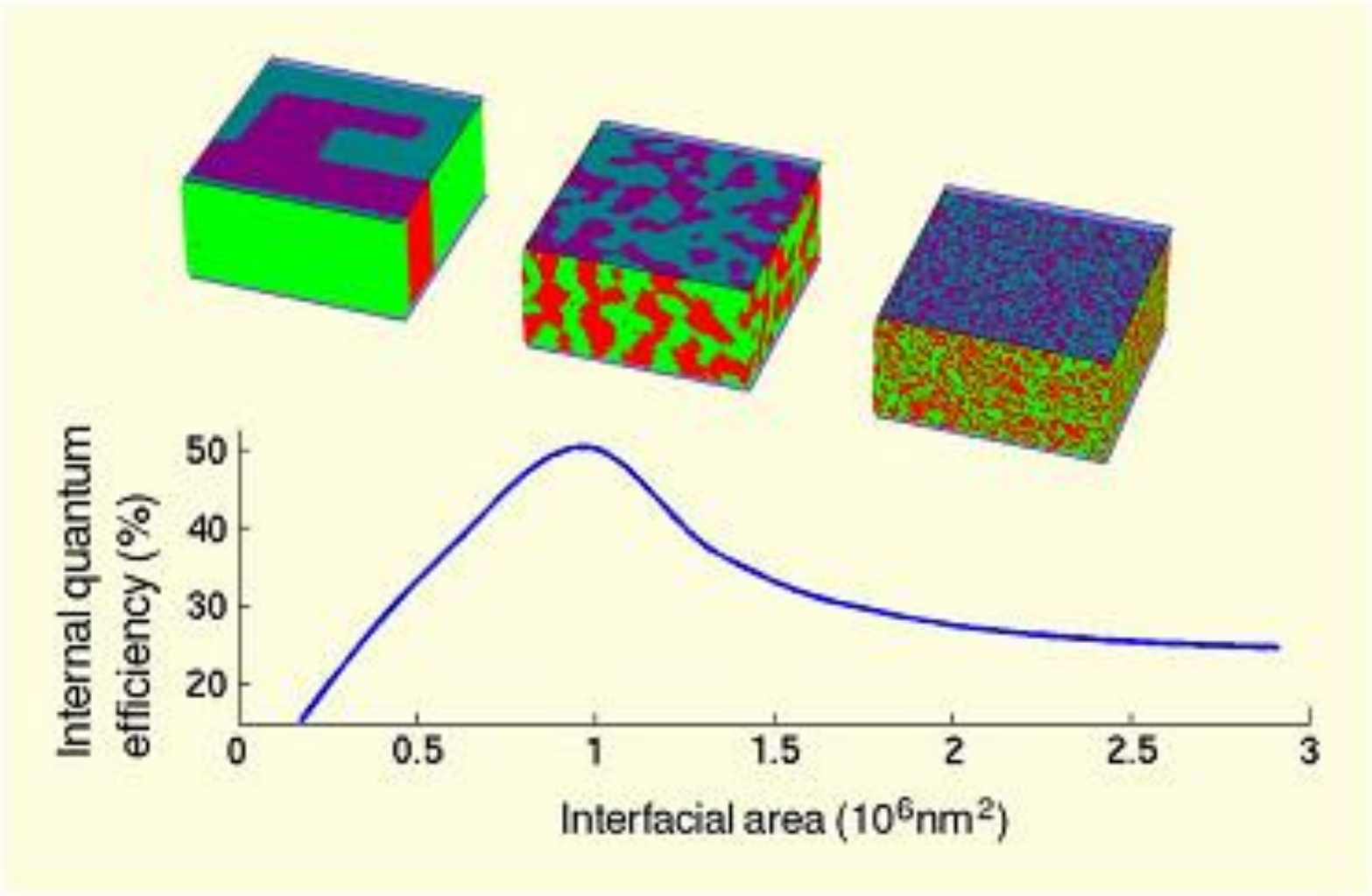


Image by Benjah



P K Watkins, A B Walker, G L B Verschoor *Nano Letts* **5**, 1814 (2005)

Acknowledgements

ABW group

Simon O'Kane
Ian Thompson
Mike Wykes

Alex Daniels
James Cave
Tom McManus
Alex Smith

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Department of Chemistry

Laurie Peter
Petra Cameron
Saiful Islam
Mike Hill
Aron Walsh
Federico Brivio
Adam Pockett
Ralf Niemann

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