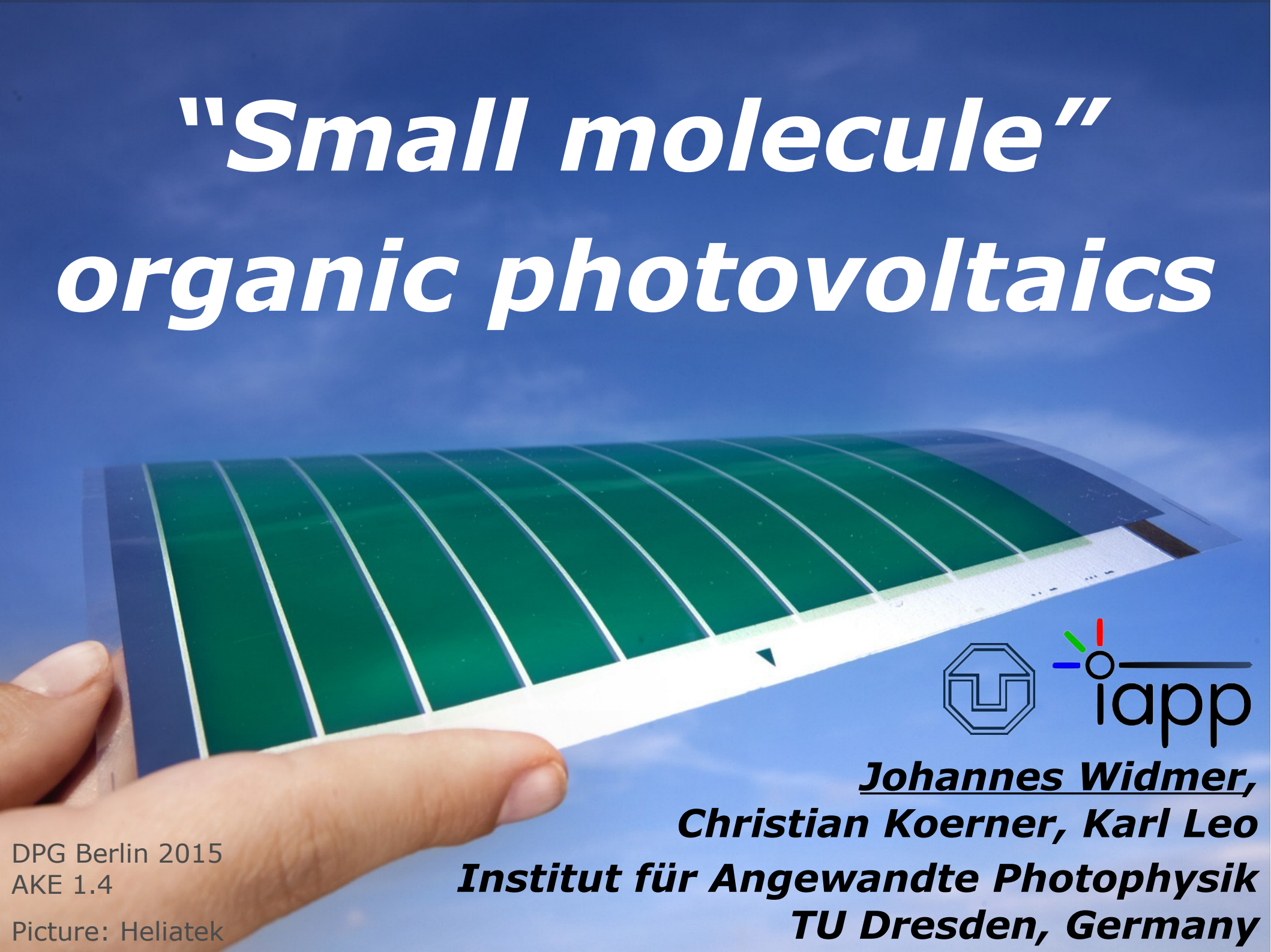
"Small molecule" organic photovoltaics



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Institut für Angewandte Photophysik

TU Dresden, Germany

DPG Berlin 2015
AKE 1.4

Picture: Heliatek

Organic photovoltaics: harvesting energy from the sun

flexible

light-weight

versatile
color, transparency

Organic solar cells are going to be found in places where we have not thought about photovoltaics yet.

Note: Slides have been reduced for online publication.

Outline

Basics

Manufacturing & functioning

Current state

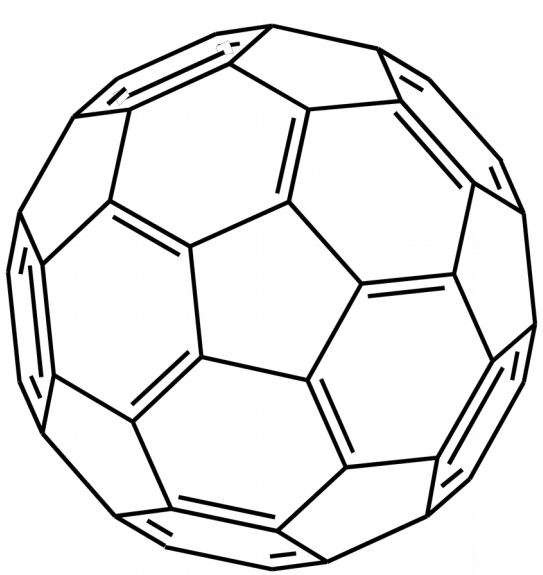
Efficiency & properties

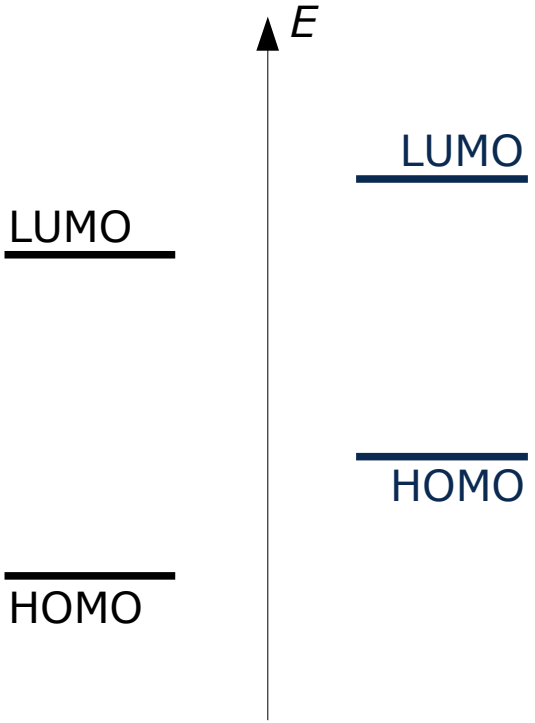
Outlook

Technology & applications

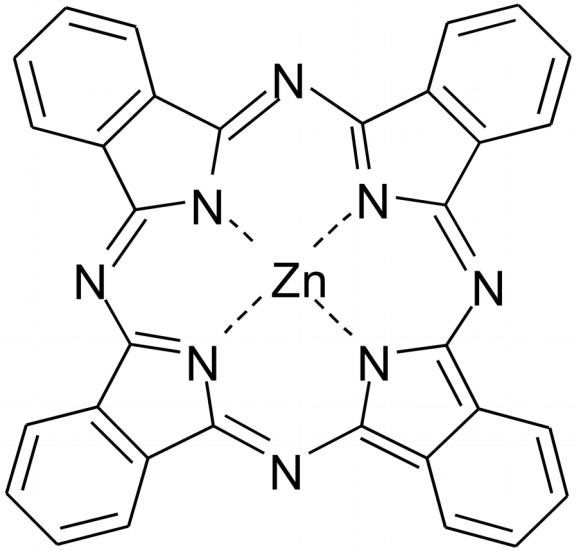
Organic dyes

C_{60}
Fullerene

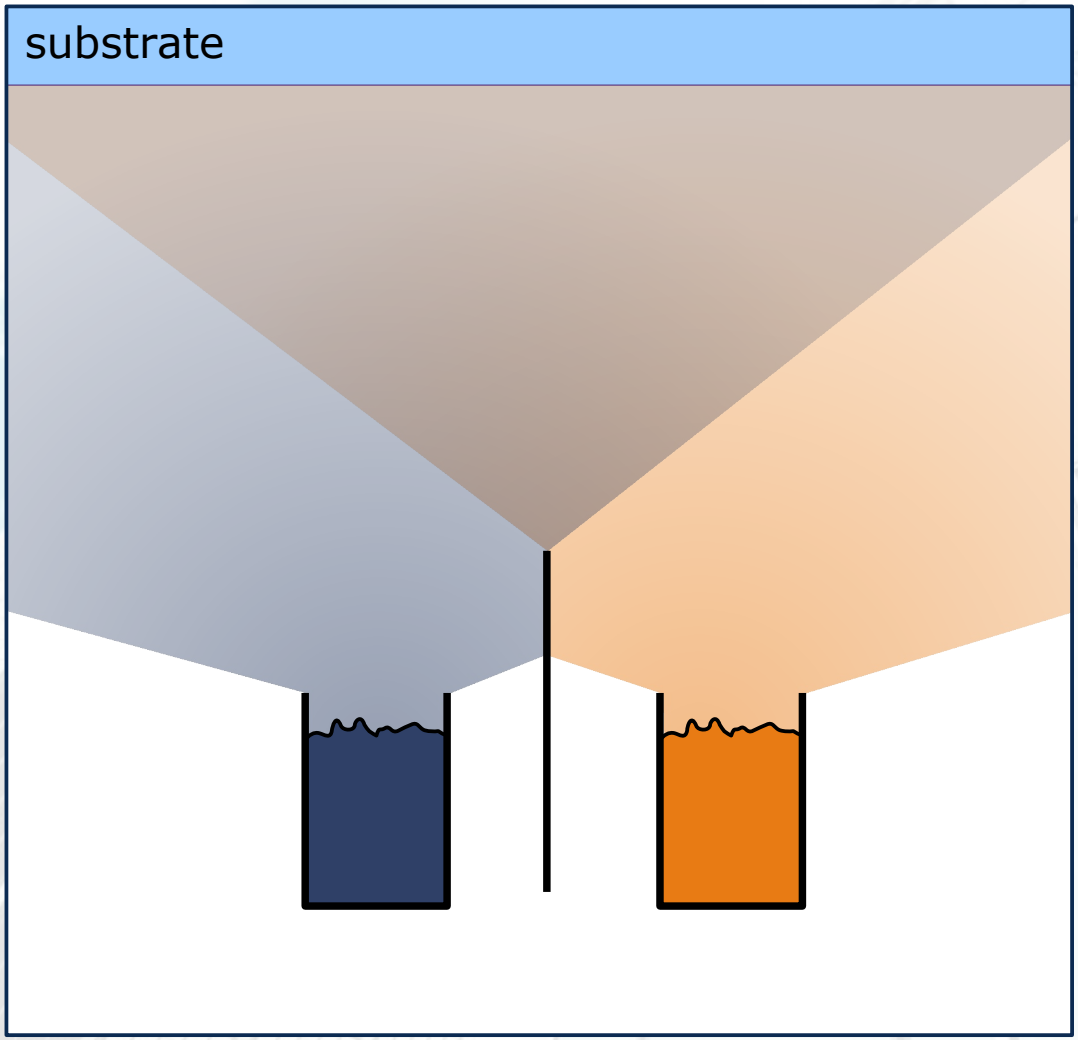




ZnPc
Zinc Phthalocyanine



Thermal evaporation in vacuum



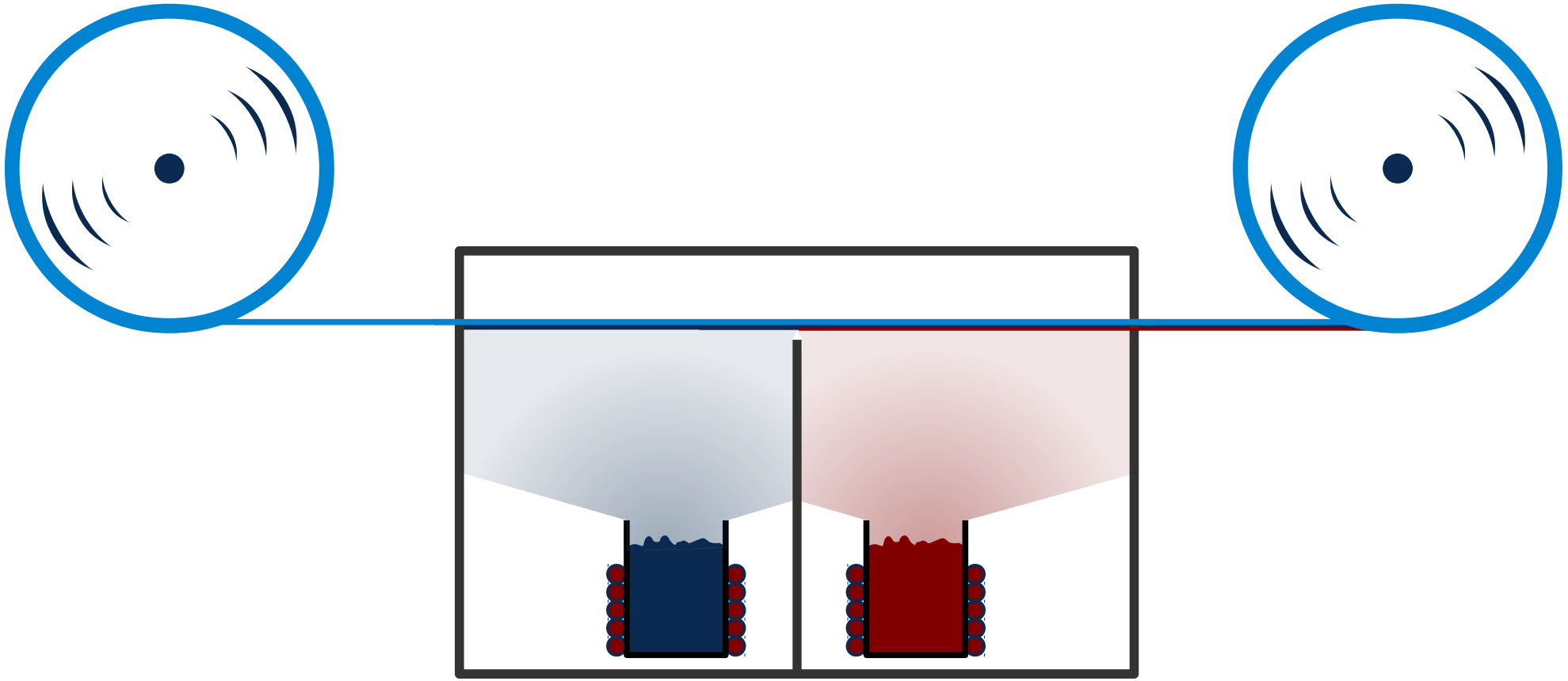
high material purity by gradient sublimation

high material stability

exact
- layer thickness
- doping, blending

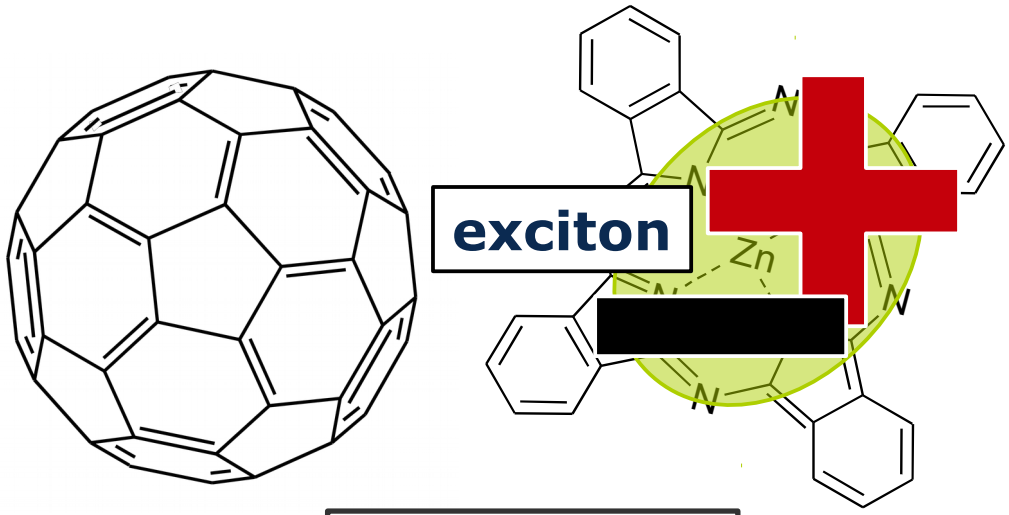
multi-layer stacks
- tandem devices
- symmetric devices

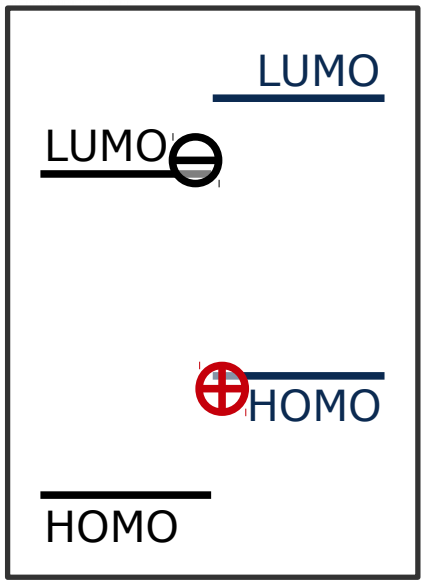
Roll-to-roll production



Exciton

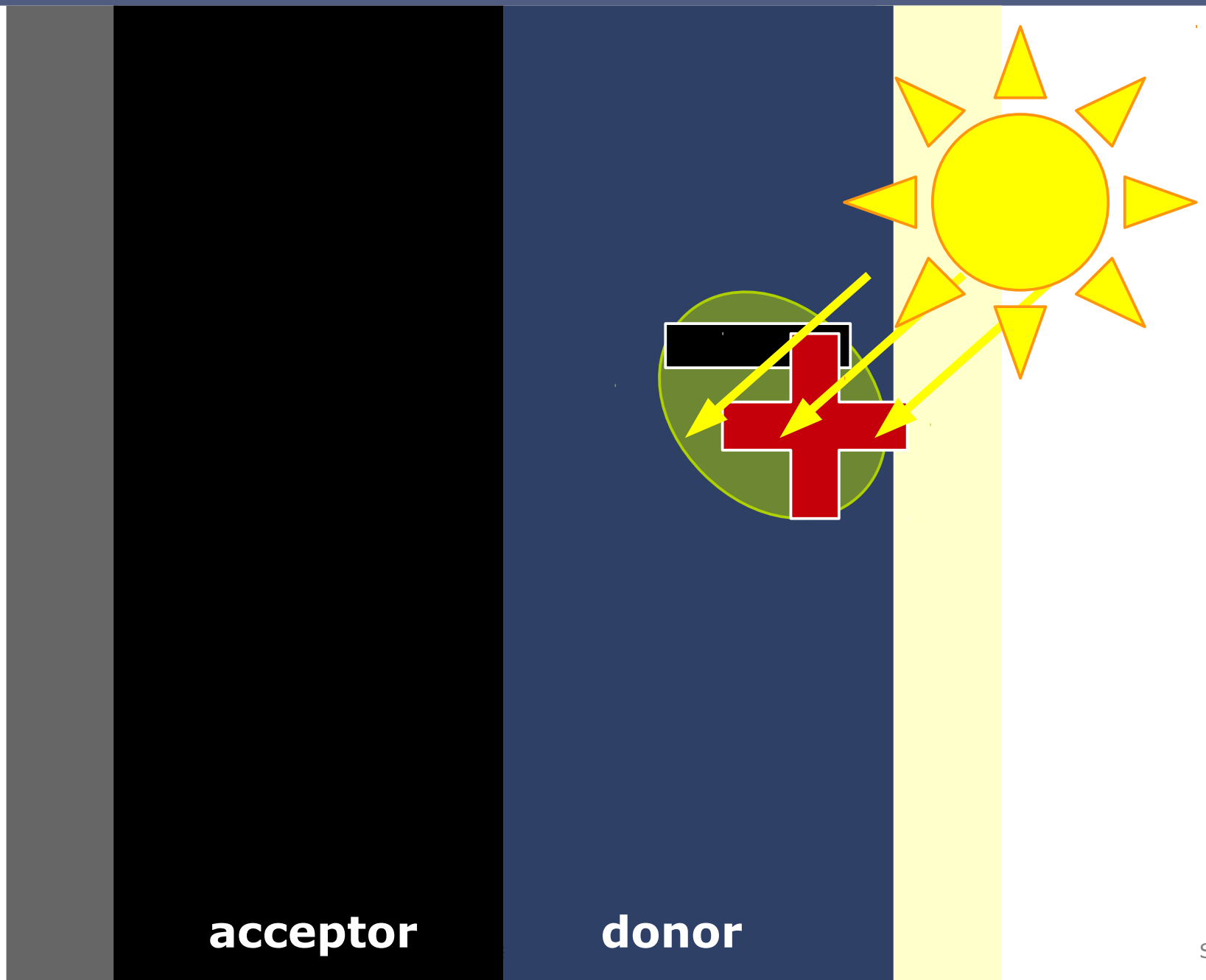
acceptor **donor**





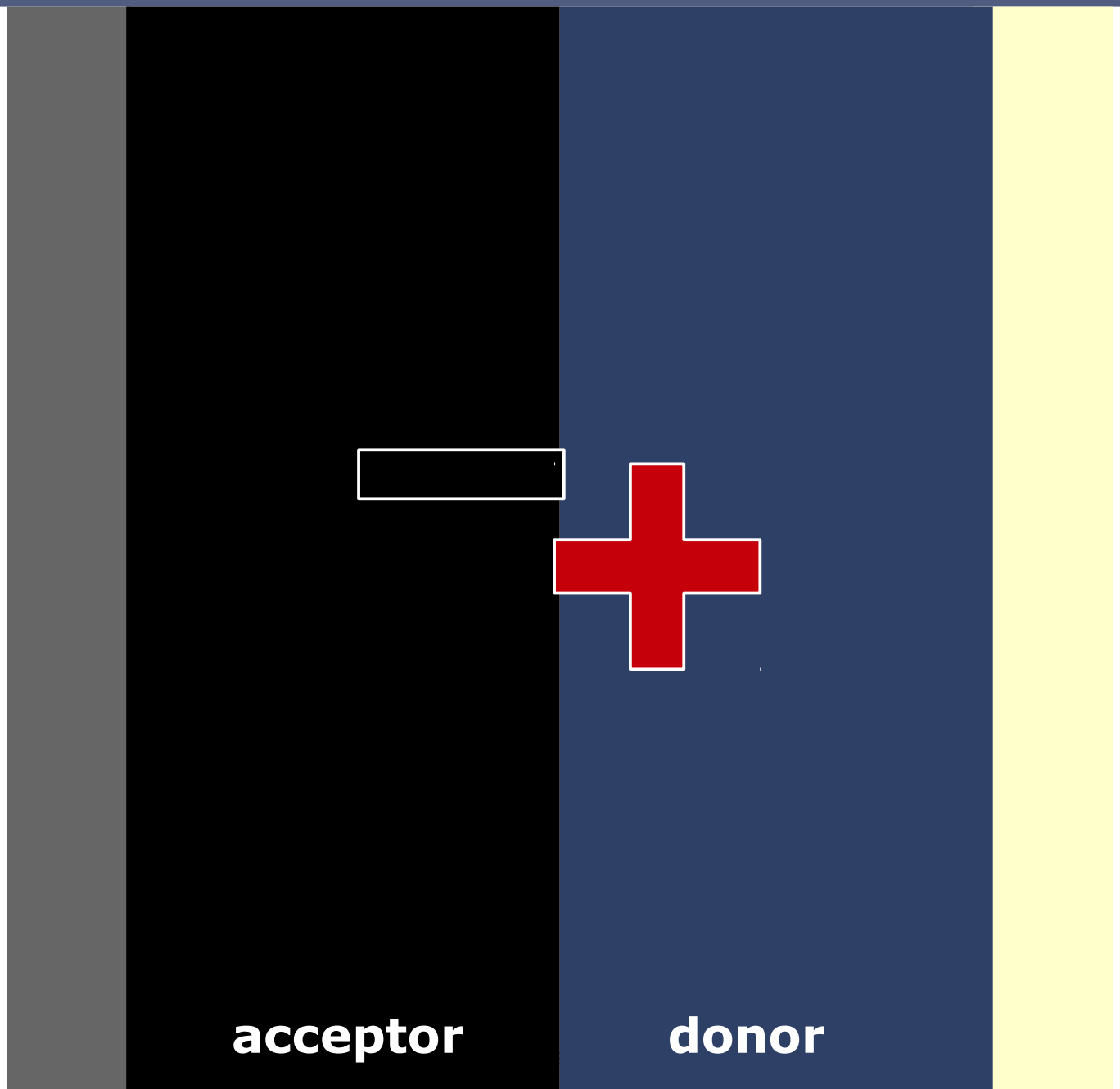
Donor acceptor thin films

contacts

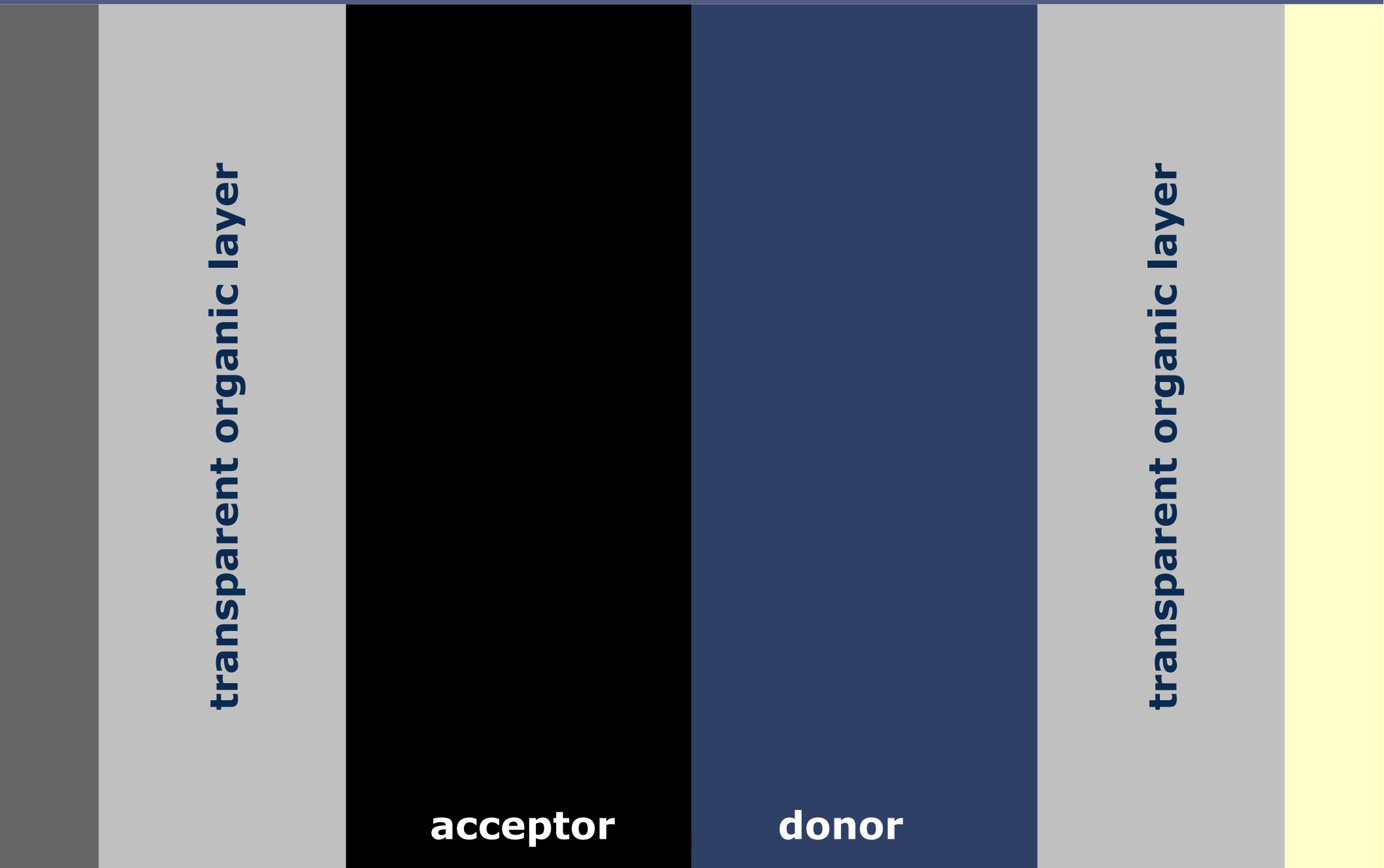


Donor acceptor thin films

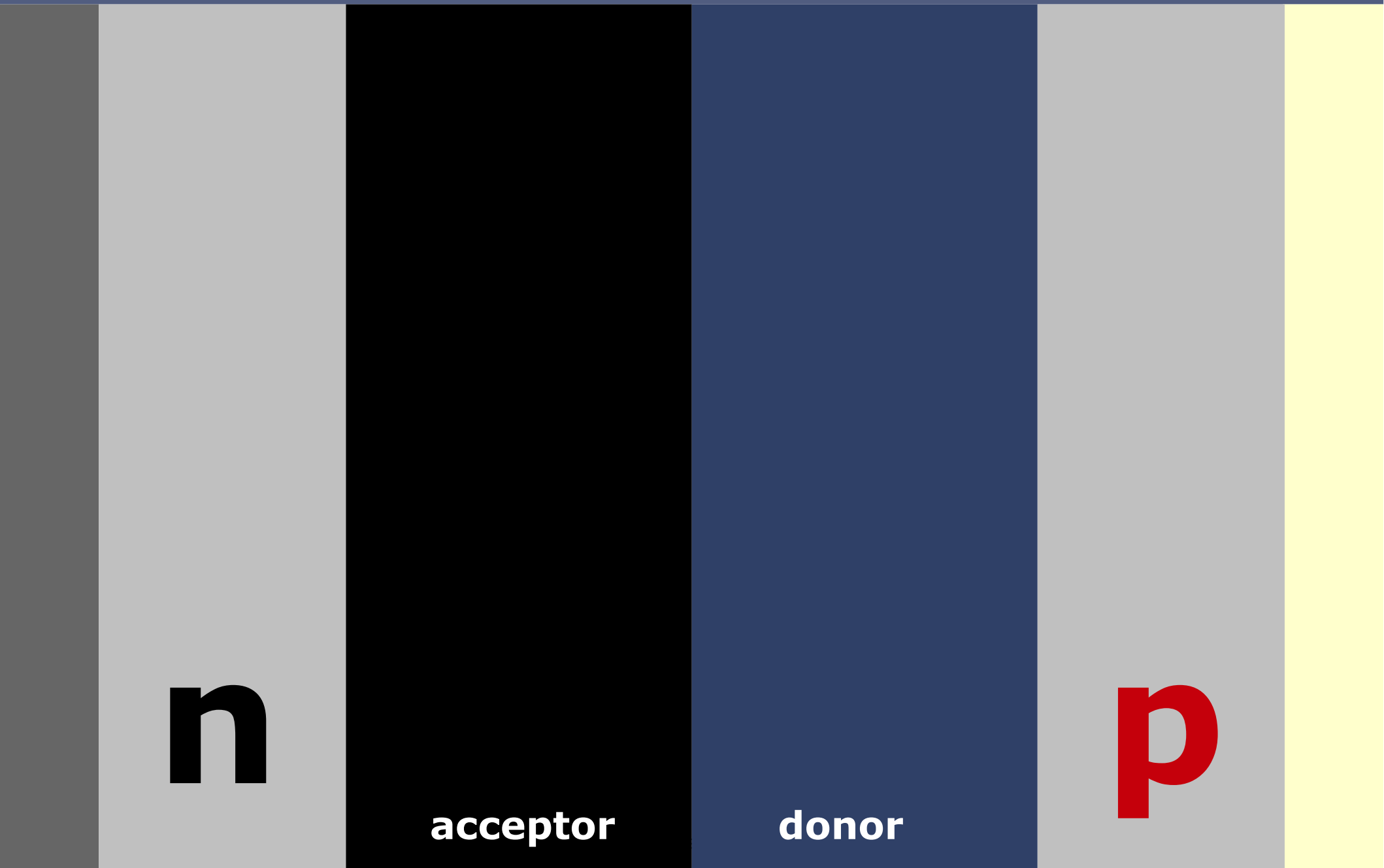
contacts



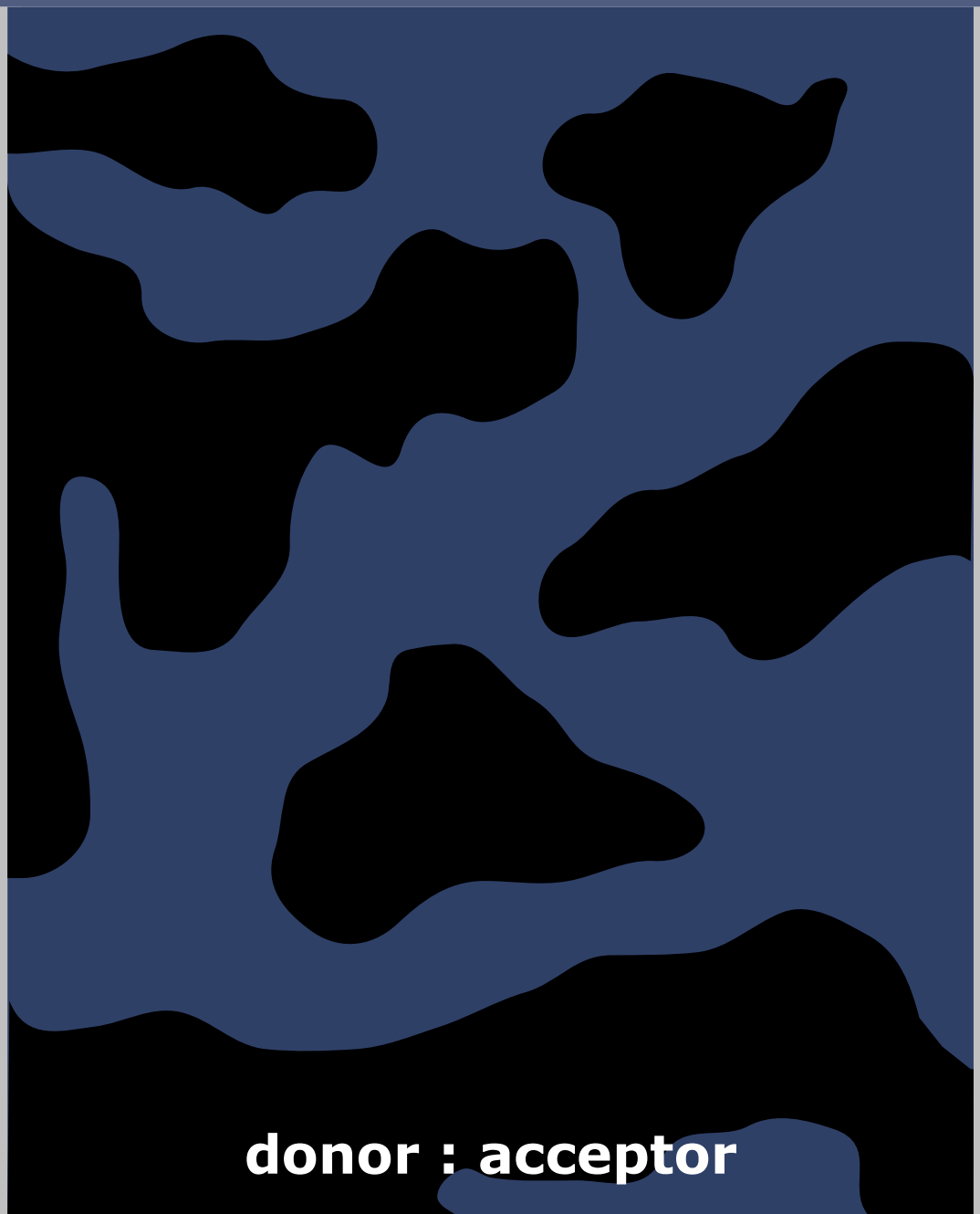
Doped transport layers



Doped transport layers



Donor:acceptor blend



n

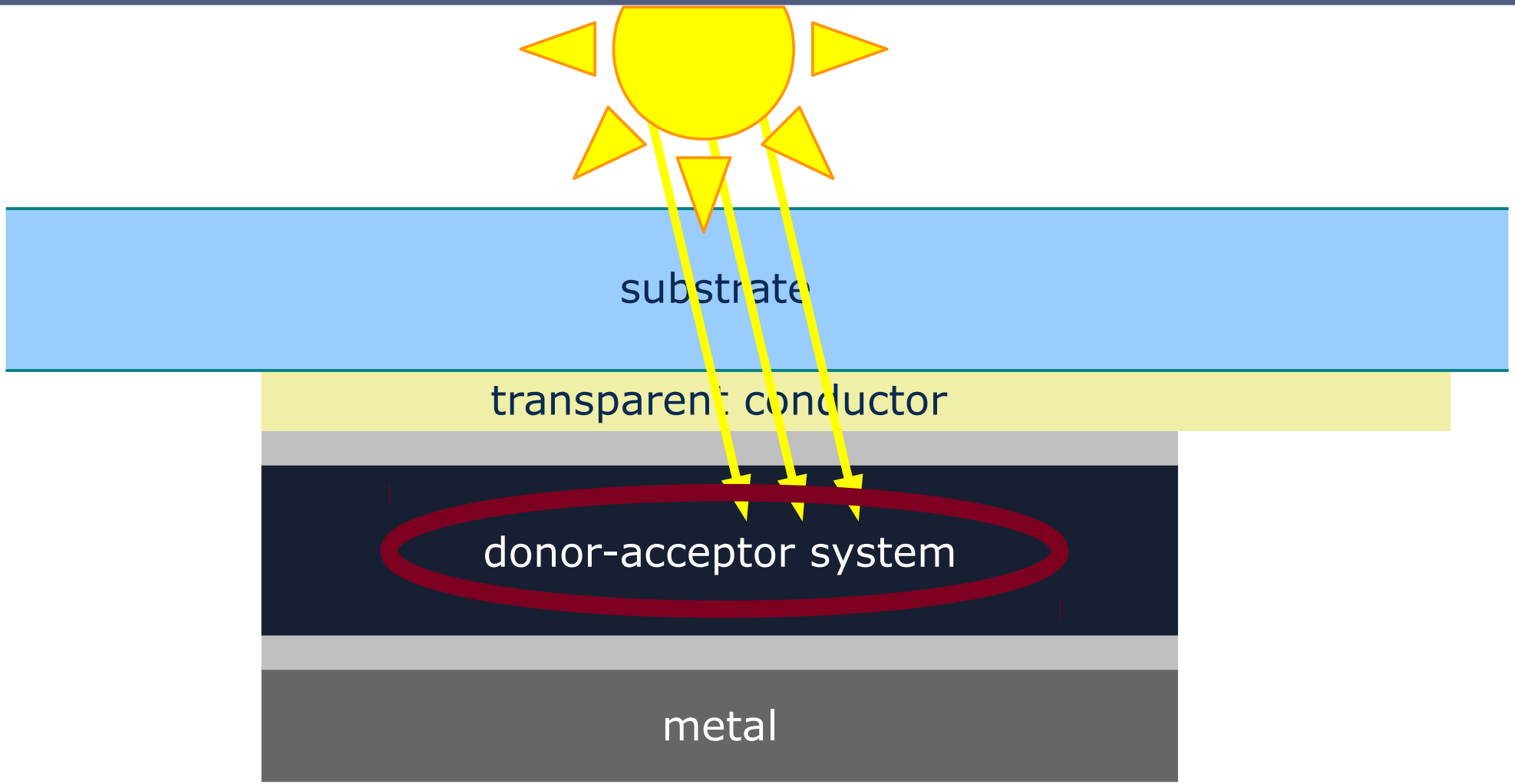
p

Solar cell stack

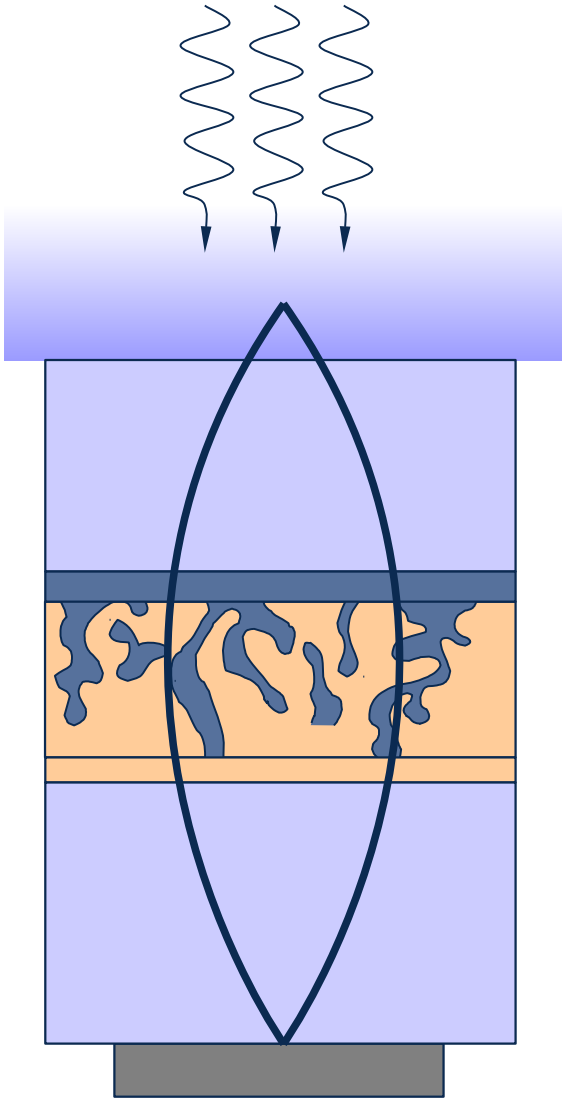
p-i-n concept

Maennig et al., Appl. Phys. A 79 1 (2004)
doi: 10.1007/s00339-003-2494-9

The complete organic solar cell



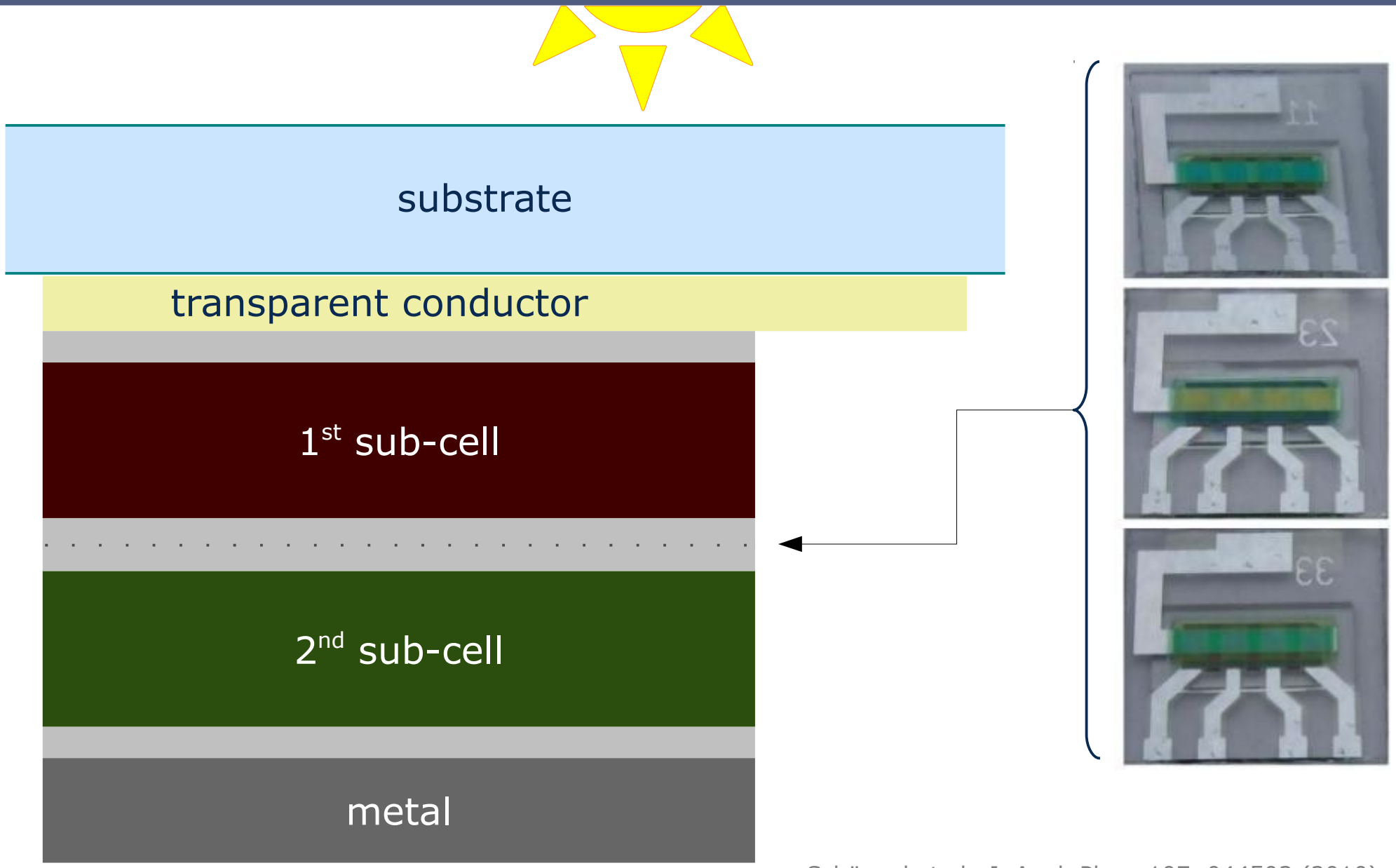
Optical design



Note: Slides have been reduced for online publication.

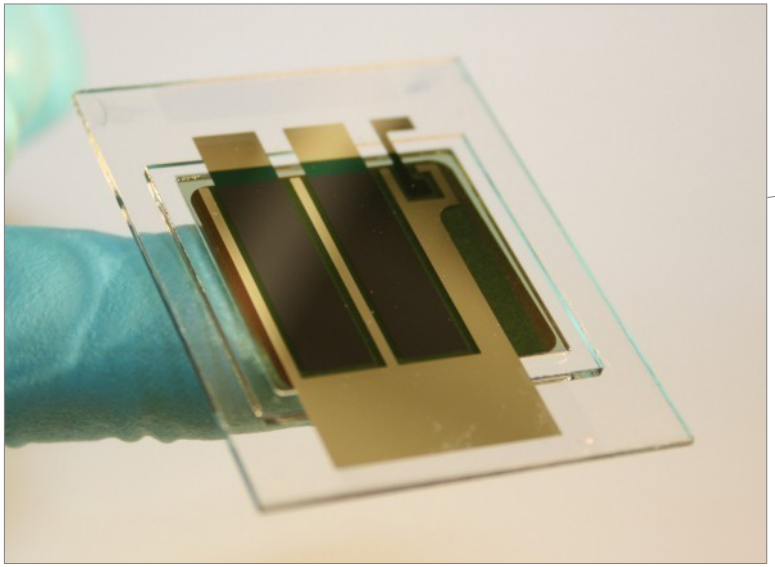
Falkenberg et al., J. Appl. Phys 110, 124509 (2011)
doi: 10.1063/1.3664828

Tandem solar cell



Schüppel et al., J. Appl. Phys. 107, 044503 (2010)
doi: 10.1063/1.3277051

Efficiency records of organic solar cells



Graph: www.orgworld.de?Record_Charts
Picture: Heliatek

Organic and inorganic solar cells

Material	Efficiency	kWh/kW$_p$	Ratio to CIGS	Ratio to c-Si
CIGS	9.3%	136	1	
c-Si	15.2%	147	1.20	1
mc-Si	8.5%	156	1.27	1.06
Organic	8.6%	187	1.38	**1.27**

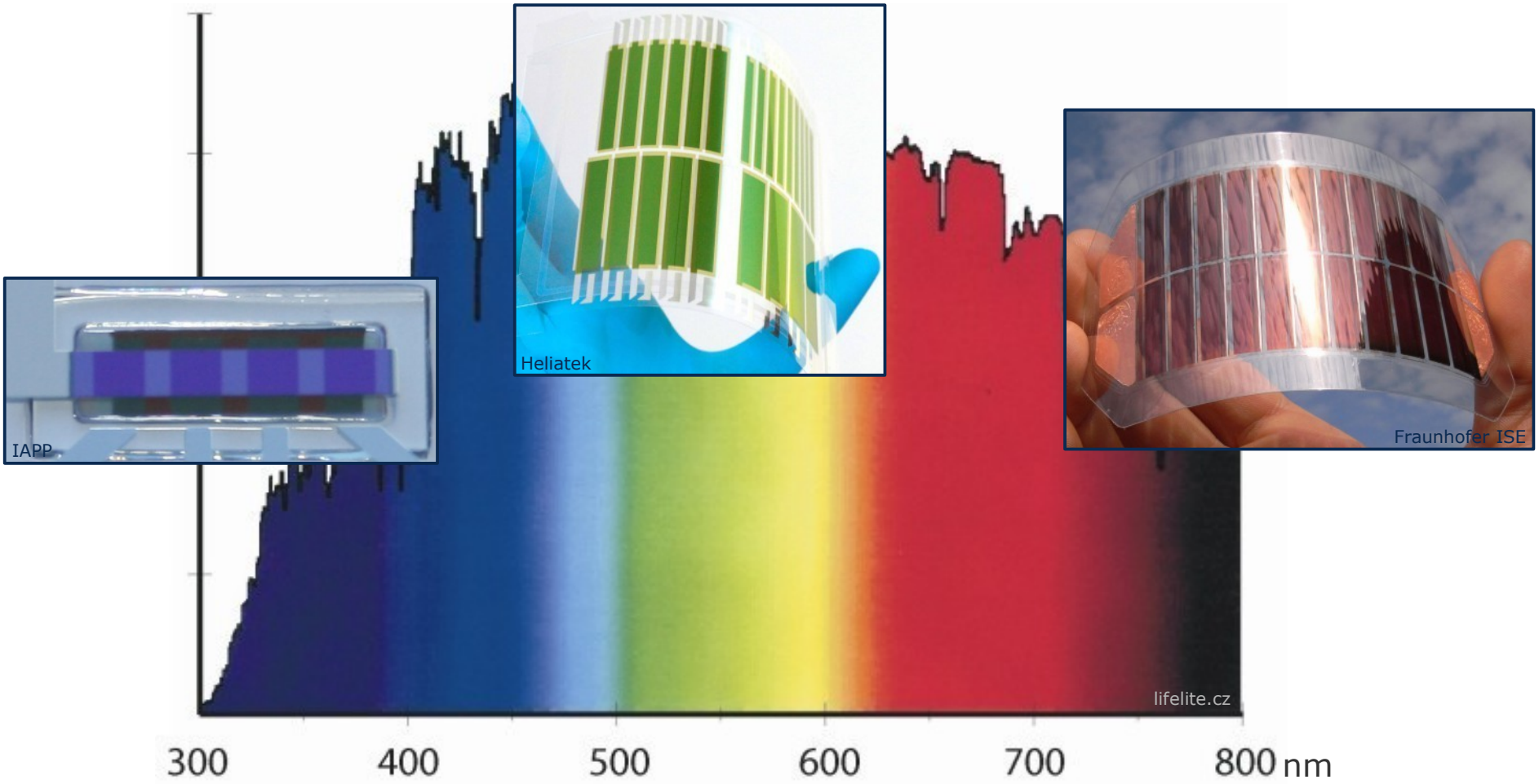
- February to April 2012
- 30^0 tilt, NW orientation
- O-Factor: +27% relative to c-Si

Heliatek®
The future is light

Recent measurement in Germany: O-Factor ≈ 14%

Courtesy: Heliatek

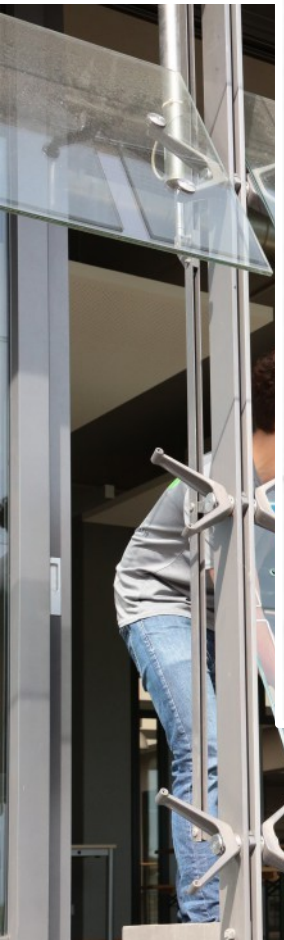
Color solar cells for architecture and design



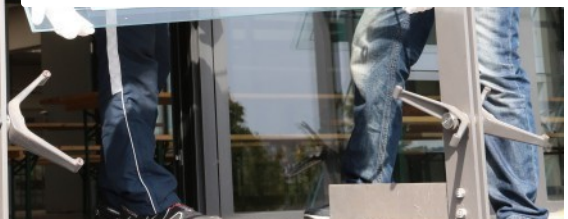
Building integrated

Pictures: Heliatek

Building integrated

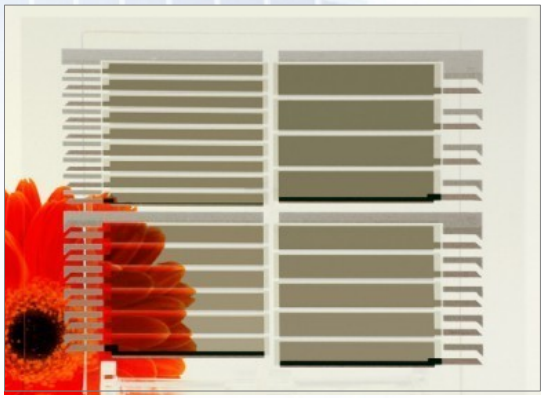


Reckli Building
Shanghai



Pictures: Heliatek

Transparency and flexibility



40% transmission
with 7.2% efficiency

Picture: C. Körner

Pictures and source: Heliatek press release

Summary

Flexible

Less than 1 mm thick solar films

Numerous colors

Homogeneous Surface

Adjustable transparency levels

Acknowledgments

IAPP OSOL group

Thanks to Organic electronics Saxony

GEFÖRDERT VOM

Bundesministerium für Bildung und Forschung

OPEG

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Thank you for your kind attention

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johannes.widmer@iapp.de

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www.oes-net.de

oes
Organic Electronics Saxony

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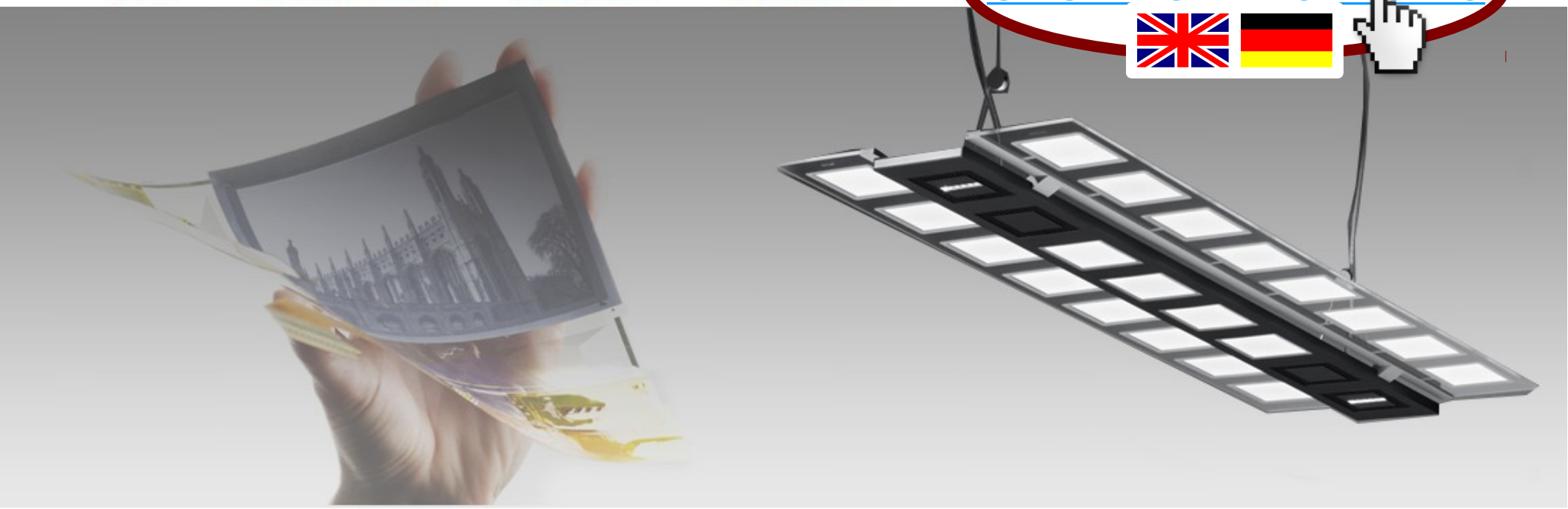
ORGANIC ELECTRONIC



Organische Elektronik verständlich:

- Einführung, Grundlagen
- Organische Solarzellen
- OLEDs
- Herstellung

Organic electronics explained:

- Introduction, basics
- Organic solar cells
- OLEDs
- Manufacturing