Thin Functional Films for solar cells and laser ablation transfer

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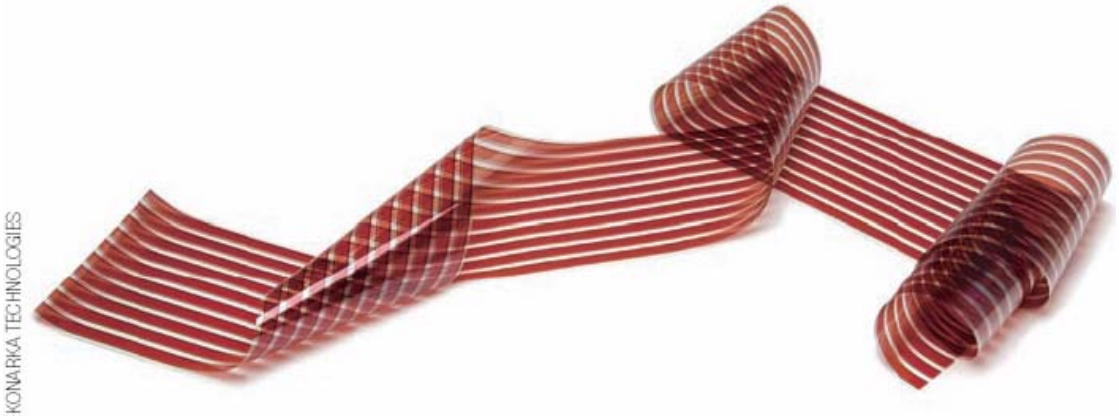
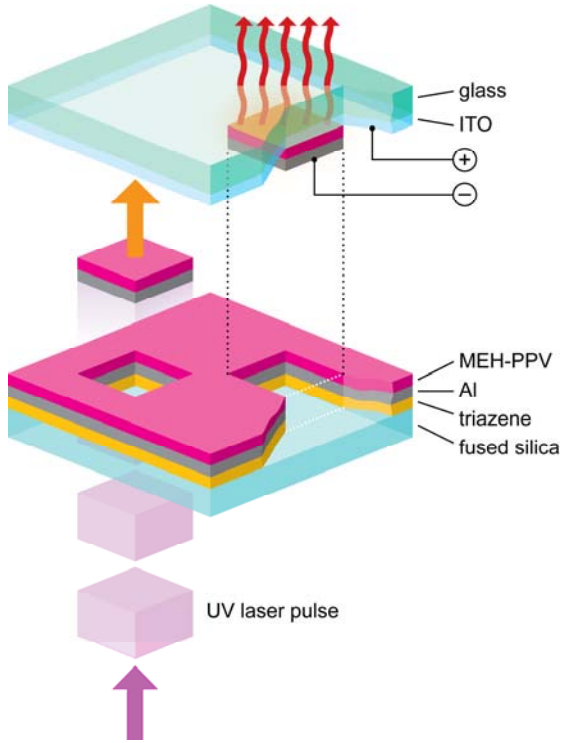
Materials synthesis and thin film devices

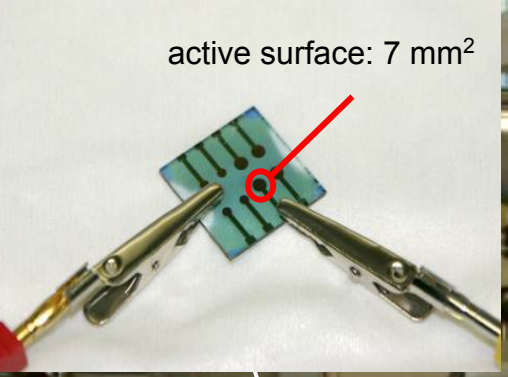
Organic solar cells



Dielectric elastomer actuators



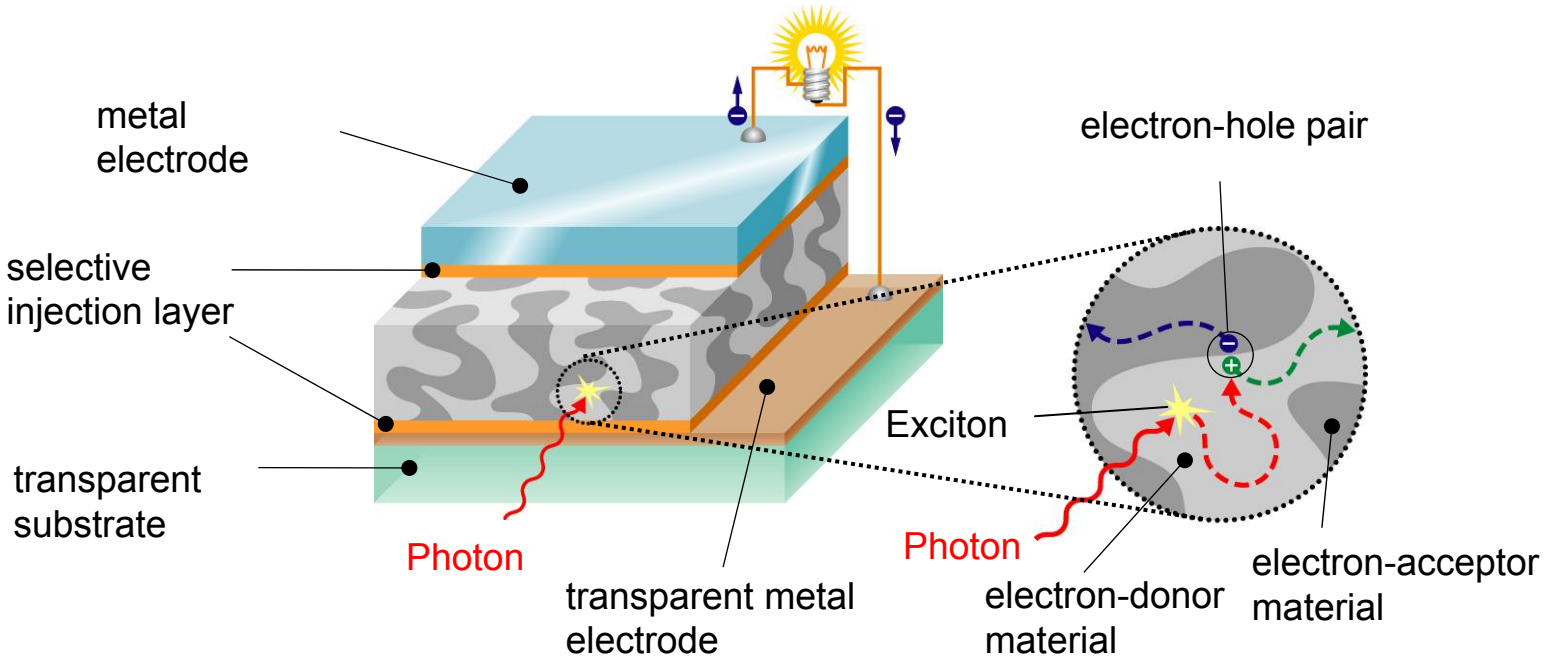
Dry laser microdeposition method



Solar cell device group

Roland Hany (GL)
Jakob Heier
Fernando Araujo de Castro
Bin Fan (PhD student)
Ylenia Maniglio (internship)
Arul Kumar (internship)
Thomas Geiger (GL)
Simon Kuster (PhD student)
Marina Simeunovic

Big challenges in organic PV



- Rising efficiency (NIR absorbing materials, multijunction solar cells)
- Enhancing charge generation and transport
- Controlling and stabilizing biphasic nanostructure in thin films
- Find suitable encapsulation methods

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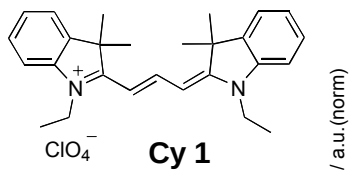
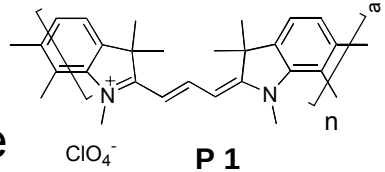
Photographic dyes for solar cells

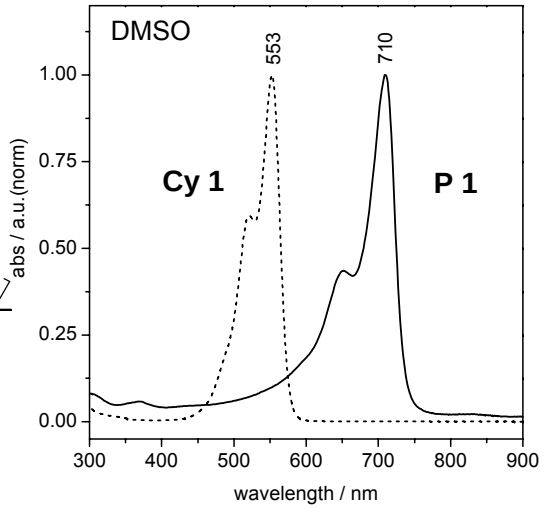
- Extremely high extinction coefficient
- Tunable absorption spectrum from UV to NIR
- Potential to form well defined crystalline aggregates with strong $\pi-$ obital overlap
- Suitable reduction and oxidation levels to act as electron acceptor or donor in the photoinduced charge separation process.

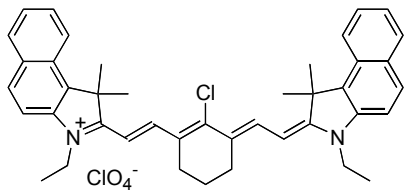


Cy 1

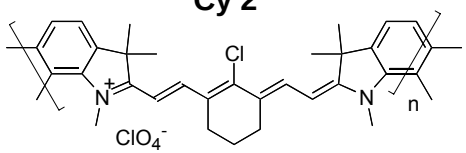


P 1

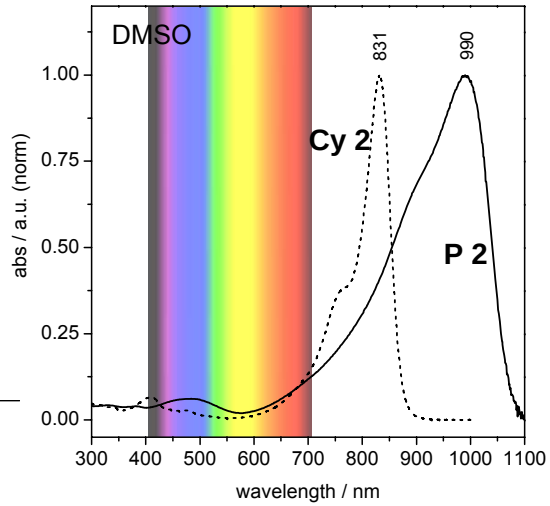




Cy 2



P 2



T. Geiger, H. Benmansour, B. Fan, R. Hany, F. Nüesch
Macromol. Rapid Commun., 29, 651-658 (2008).

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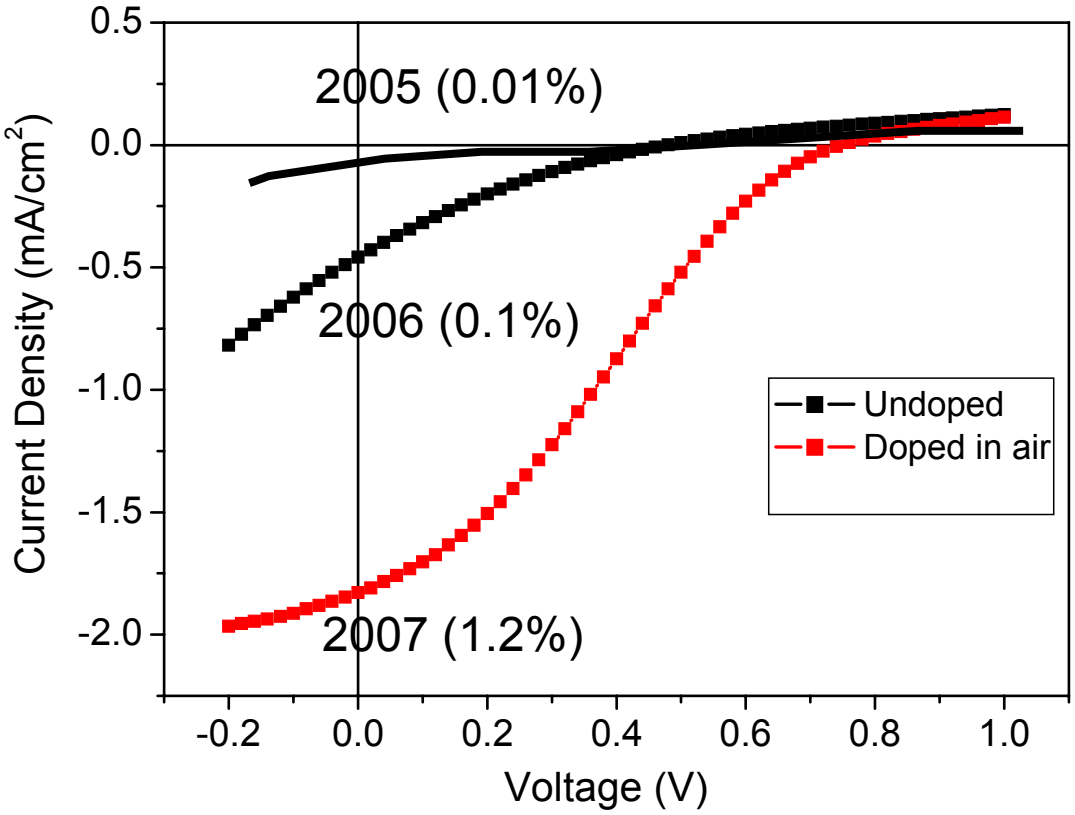
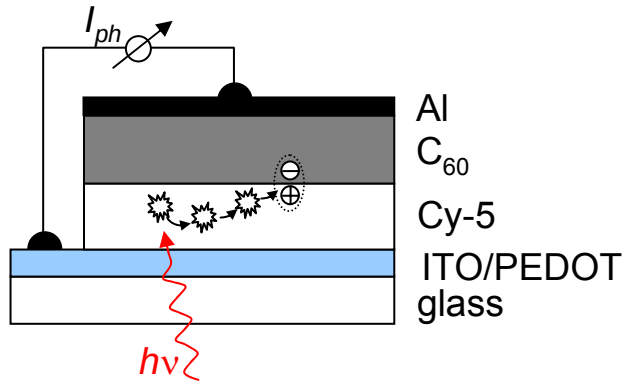
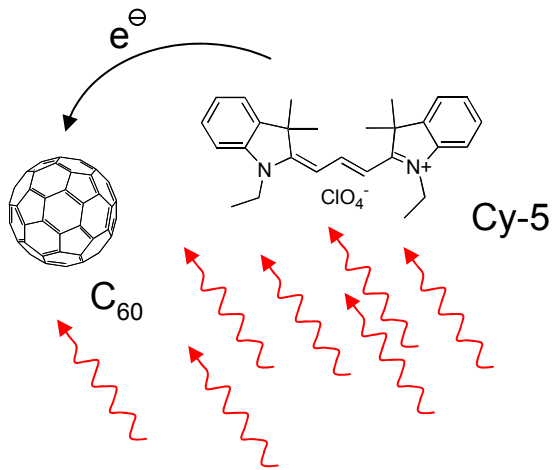
High performance doped cyanine solar cells







F. Meng, K. Chen, H. Tian, L. Zuppiroli, F. Nüesch, *Appl. Phys. Lett.*, 83 (21), (2003), p. 3788-3790

B. Fan, R. Hany, J. E. Moser, F. Nüesch, *Org. Electronics,* 2008, 9, 85-94

B. Fan et al., 2008 *to be published*

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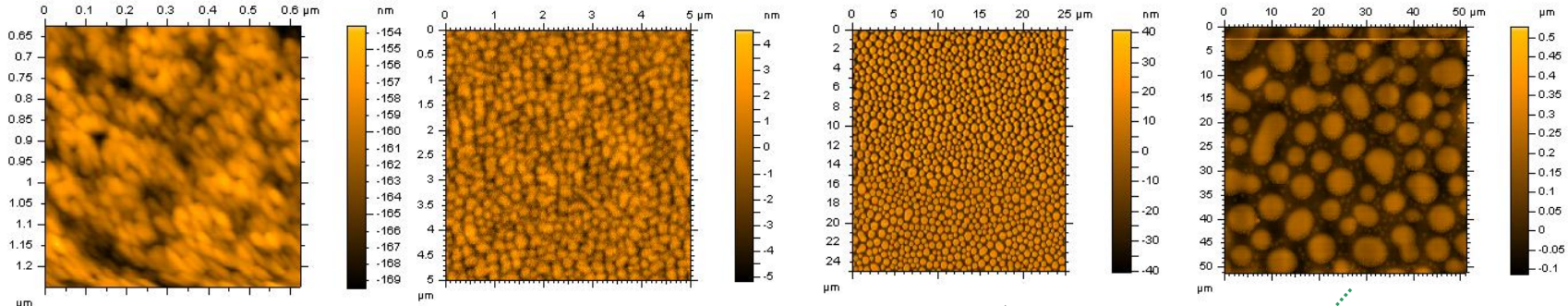
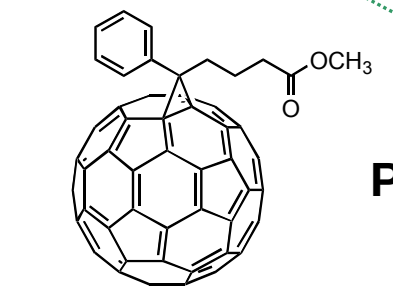
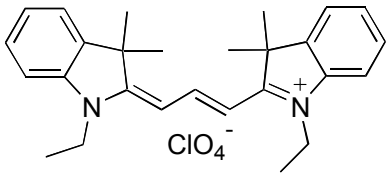
Nanostructuring of thin cyanine films

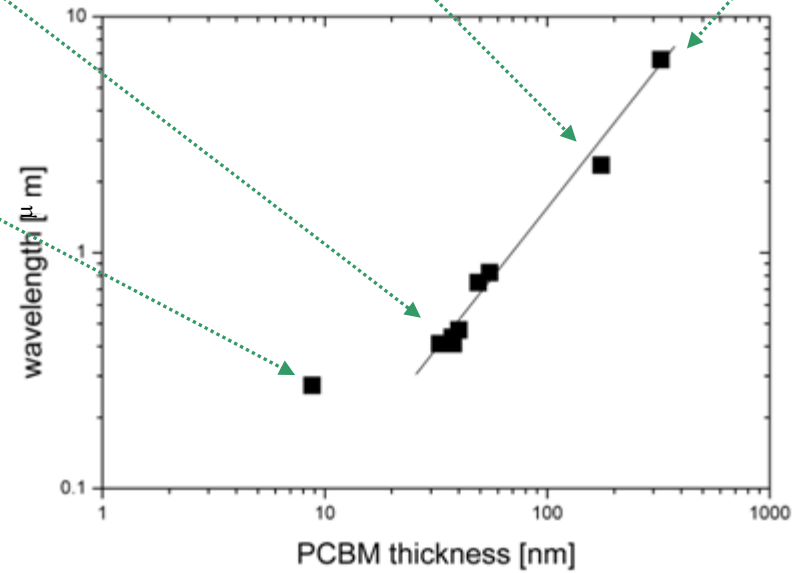




PCBM



Cy-5



F. A. Castro, C.F.O. Graeff, J. Heier, R. Hany, *Polymer*, 48, (2007), 2380-2386
J. Heier, F. A. Castro, F. Nüesch, R. Hany, *SPIE Int. Soc. Opt. Eng.*, 6656 66560 P1-P10, (2007)
J. Heier, J. Groenewold, F. A. Castro, F. Nüesch, R. Hany, *Proc. of SPIE* Vol. 6999 69991J-1 (2008)
J. Heier, J. Groenewold, S. Huber,. F. Nüesch, Roland Hany, *Langmuir*, 2008, in press

cost

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CCEM project ThinPV

swisselectric research

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Zürcher Hochschule Winterthur

Greatcell Solar

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Next event:
PV PhD-Workshop in Ascona, Nov 16th-18th 2008
Confirmed speakers: Prof. L. Peter (U. Bath), Prof. M. Burgelman (U. Gent), Prof. R. Janssen (U. Eindh.), Dr. T. Coutts (NREL), Prof. B. Rech (Hahn-Meintner Inst., Berlin)

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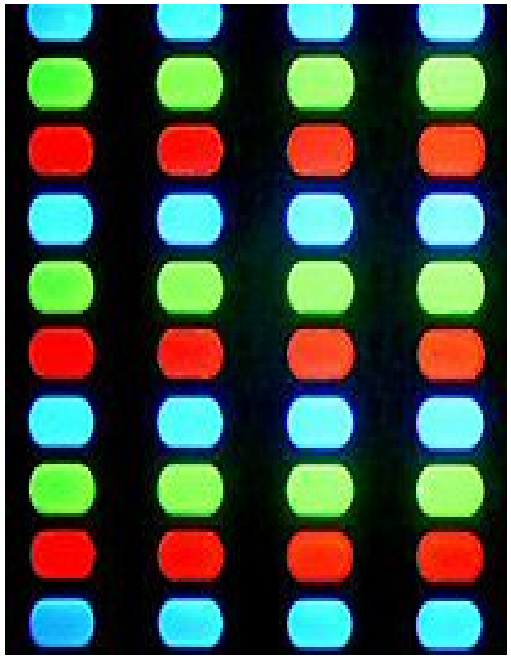
Patterned thin film polymer devices by laser-induced forward transfer

Romain Fardel, Matthias Nagel, Frank Nüesch
Empa, Laboratory for Functional Polymers
Thomas Lippert, Alexander Wokaun
Paul Scherrer Institut, General Energy Research Department



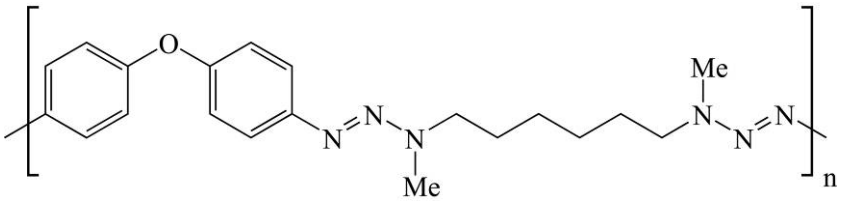
- Production techniques :
  - spin-coating : no structure
  - evaporation : not for polymers
  - inkjet, screen printing : intermixing of the layers
  - photolithography : photoprocessible material required

→ new method proposed…

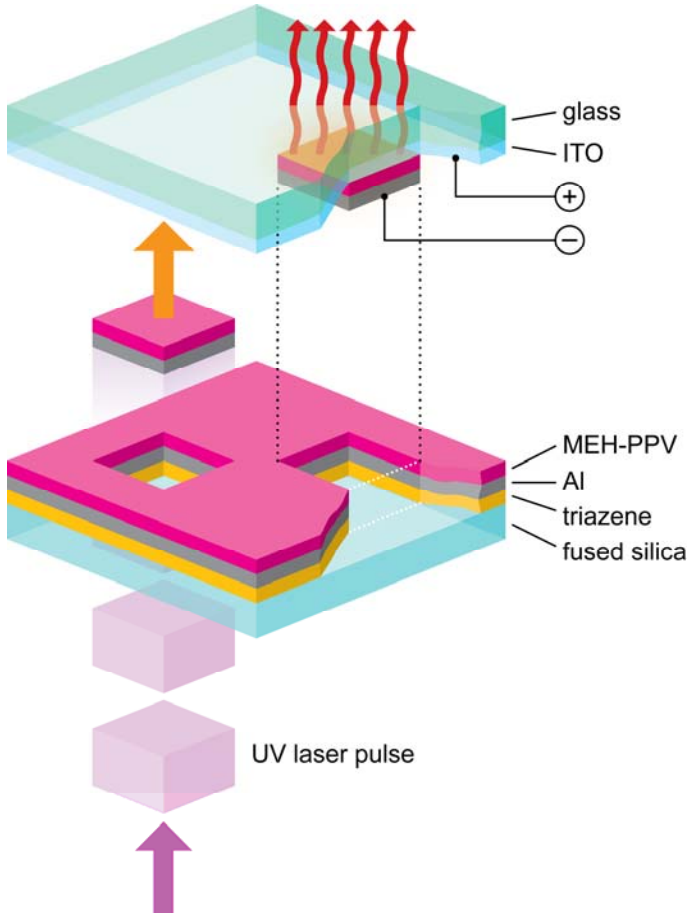
Work founded by FNSNF Swiss National Science Foundation EMPA Materials Science & Technology

Laser-induced forward transfer using a photodynamic release layer

Use of a UV-sensitive
<u>dynamic release layer</u>



triazene polymer



Advantages :

- Dry transfer technique → not limited by the solvent
- Three-dimensional structuring allowed
- Low thermal impact, debris-free ablation

M. Nagel et al., *Marcomol. Chem. Phys*., 208 (2007), 277-286

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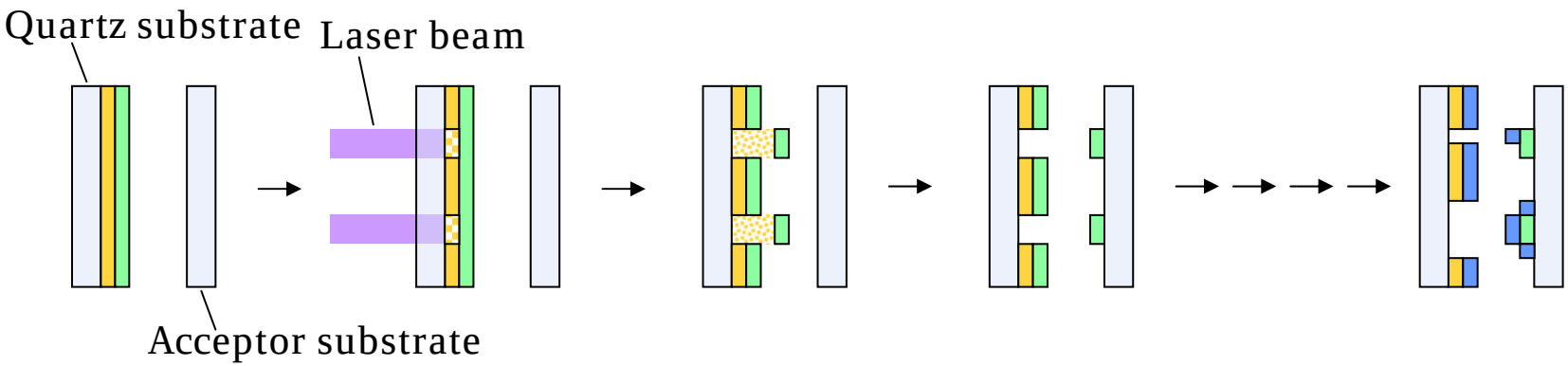
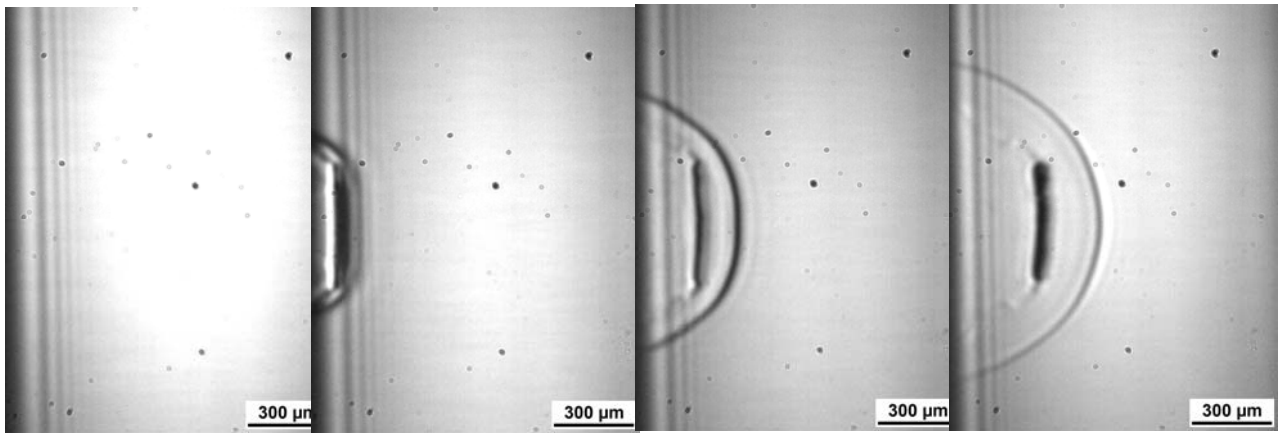
Forward Transfer





0 ns 200 ns 400 ns 600 ns

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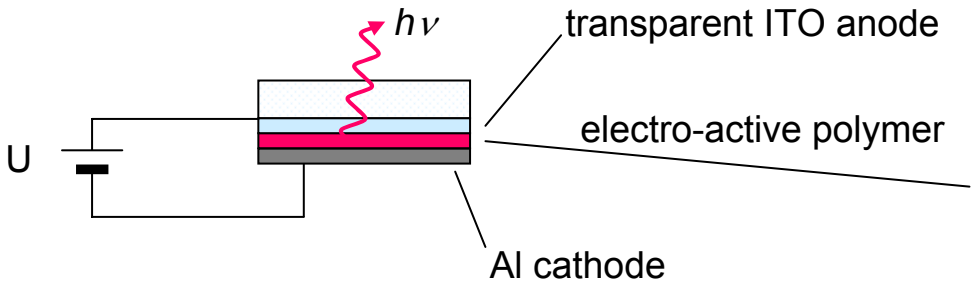
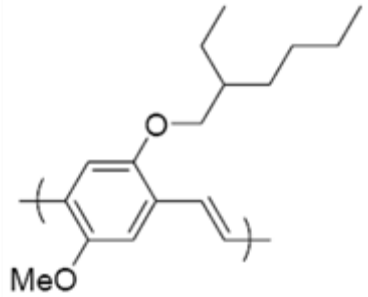
Transfer of Al/MEH-PPV

Typical configuration of a basic OLED :

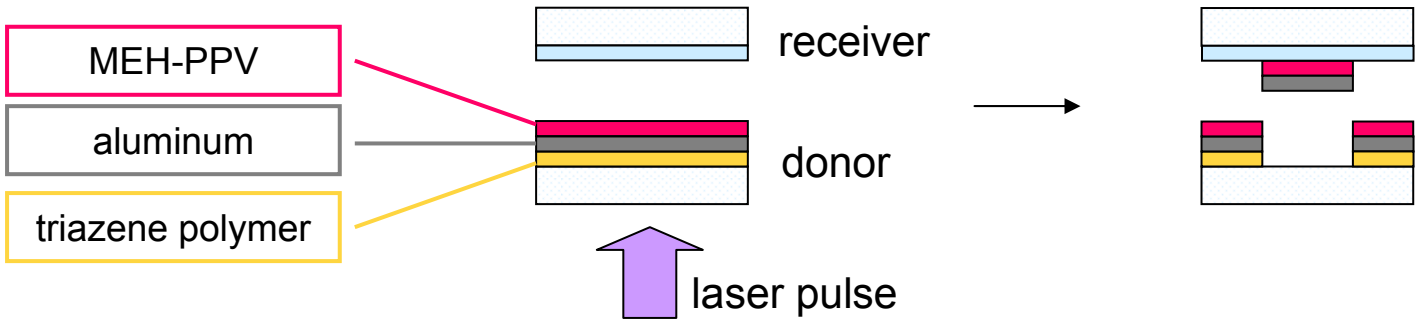


MEH-PPV



poly(2-methoxy,5-(2'-ethylhexyloxy)-1,4- phenylene vinylene)

OLED configuration can be achieved by a one-step transfer process :



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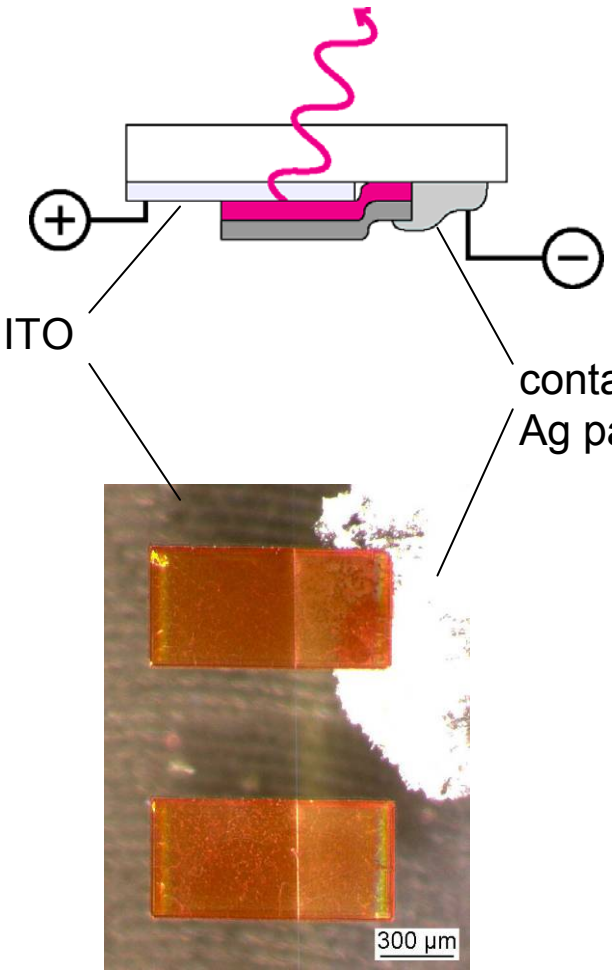
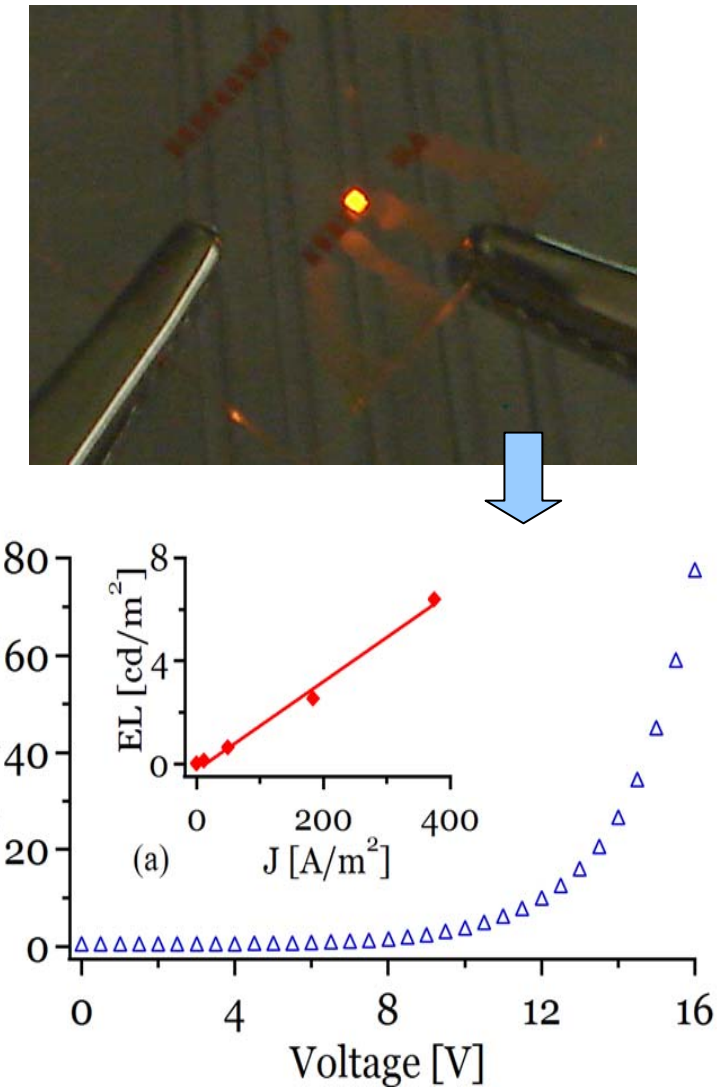
OLED fabricated by the LIFT method

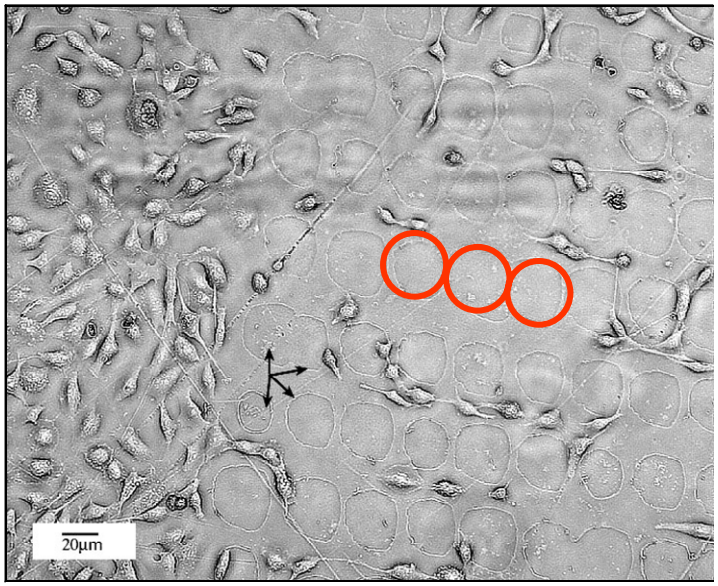




R. Fardel et al., *Appl. Phys. Lett.* **91**, 061103 (2007)

Transfer of living cells („Bio laser printing“)

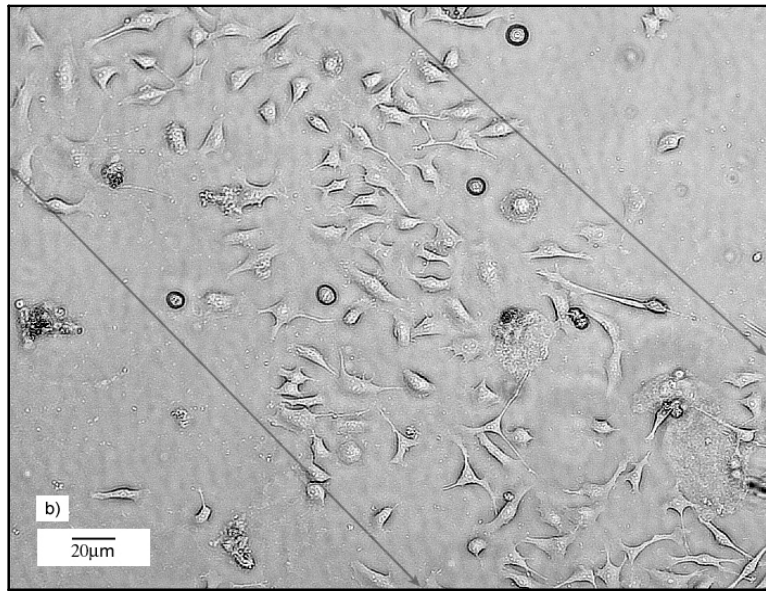
Neuroblast B35 cells in extracellular matrix



ArF*
193 nm
50 mJ cm^{-2}

DRL ~100 nm

gap = 150 mm



Donor substrate after transfer

Receiver substrate: transferred cells

A. Doraiswamy, R. Narayan, T. Lippert, L. Urech, A. Wokaun, M. Nagel, B. Hopp, M. Dinescu, R. Modi, R. Auyeung, D. Chrisey, Appl. Surf. Sci. **252**, 4743 (2006).

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Thank you for your attention !

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