PROCESS TECHNOLOGIES FOR ADVANCED ORGANIC ELECTRONIC DEVICES: MICRODISPLAYS, LIGHTING AND SOLAR CELLS

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Fraunhofer IPMS - Center for Organic Materials and Electronic Devices Dresden COMEDD

Innovations for Industry
– at MicroNanoTec,
Hannover, April 20th, 2010

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OUTLINE

- COMEDD introduction
- OLED basics
- OLED lighting
  - Pilot line for substrates 370 x 470 mm²
  - R2R fabrication of OLED
- Organic solar cells
  - ZnPc:C60 tandem cell
  - Transparent organic solar cell
- OLED-on-CMOS
  - VGA OLED microdisplay
- COMEDD offer and network

CENTER FOR ORGANIC MATERIALS AND ELECTRONIC DEVICES DRESDEN

COMEDD as trademark of Fraunhofer IPMS

- Opened in 200
  investments of about 30 M€ (EU, Sachsen, FhG)

Mission

- Customer and Application Specific Research, Development and Pilot fabrication on novel device concepts and manufacturing methods in the field of organic electronics (small molecule)

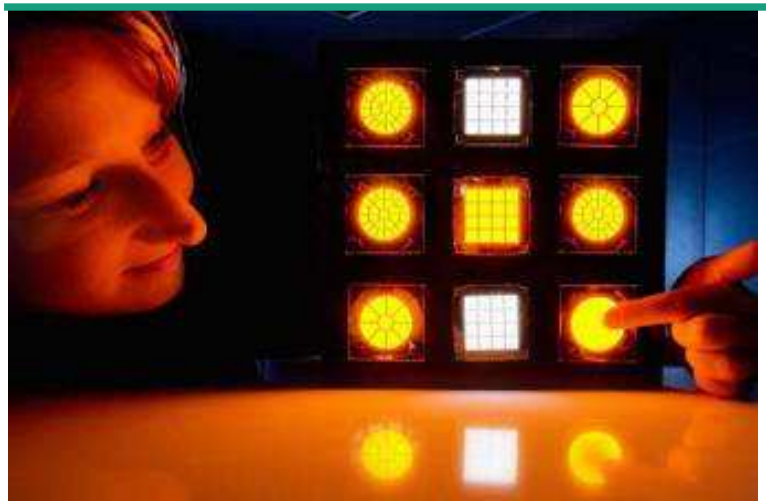
Infrastructure

- Clean room 900 m², Labs 100 m²

Fabrication lines

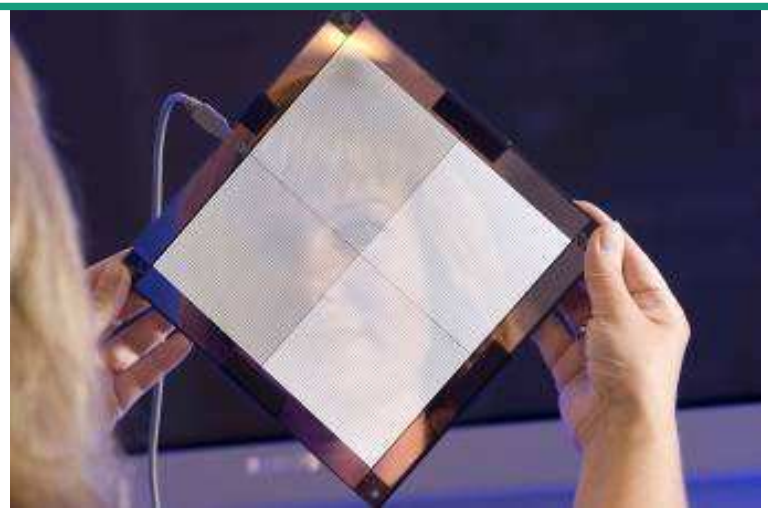
- Pilot line Gen2 (370 x 470 mm²)
- Pilot line OLED-on-CMOS (200x200 mm²)
- Roll-to-Roll line (300 mm foils)

APPLICATIONS

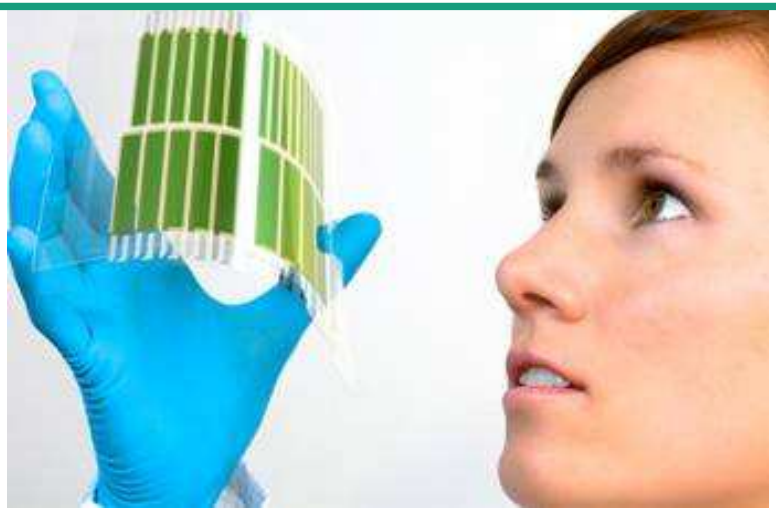


Signage

OLED on CMOS



Lighting



Organic Photovoltaics

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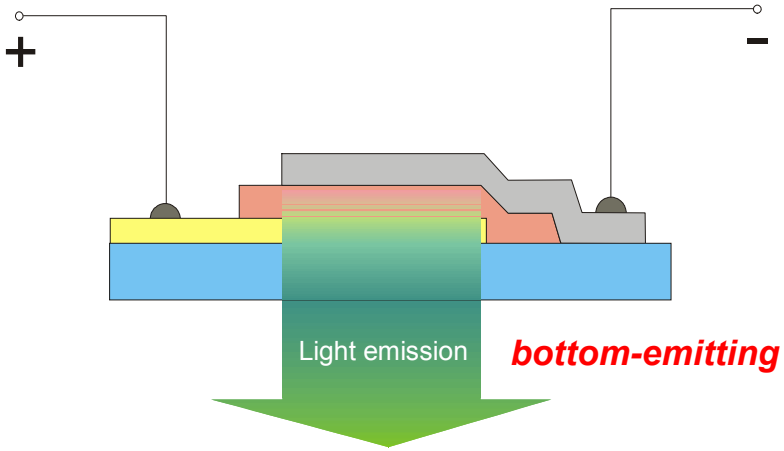
INTRODUCTION OLED

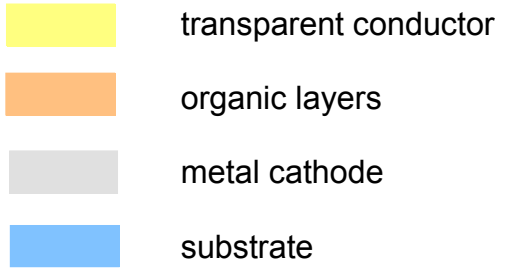
Key features

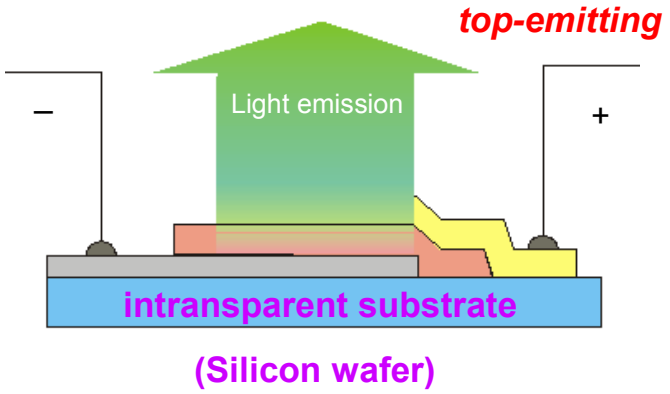
- Polymer or small-molecule layers
- Extremely thin (~100nm)
- large area possible
- arbitrary shapes
- all colors (RGB, white)
- emissive/wide viewing angle

Backplanes/applications

- bottom-emitting
  - lighting, signage
  - displays (PM, AM)
- top-emitting
  - displays (AM: a-Si, LTPS)
  - micro-displays (OLED-on-CMOS)
  - micro-systems/sensors (OLED-on-CMOS)







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WHY OLED FOR LIGHTING?

- Very thin and light weight
  - Total thickness < 2mm
- Broad perspective (wide view angle)
  - Diffuse Lighting, Lambert emission
- Huge selectivity of materials
  - Polymer (Spin-Coated) and Small-Molecule (Evaporated) Material
  - Non toxic materials
- Low cost manufacturing with simple structure
- Large area possible
- Low power consumption
- Highly efficient
  - Green (130 lm/W)
  - White (90 lm/W)
- Low material consumption (~1 gr. material/m²)
- Low surface heating

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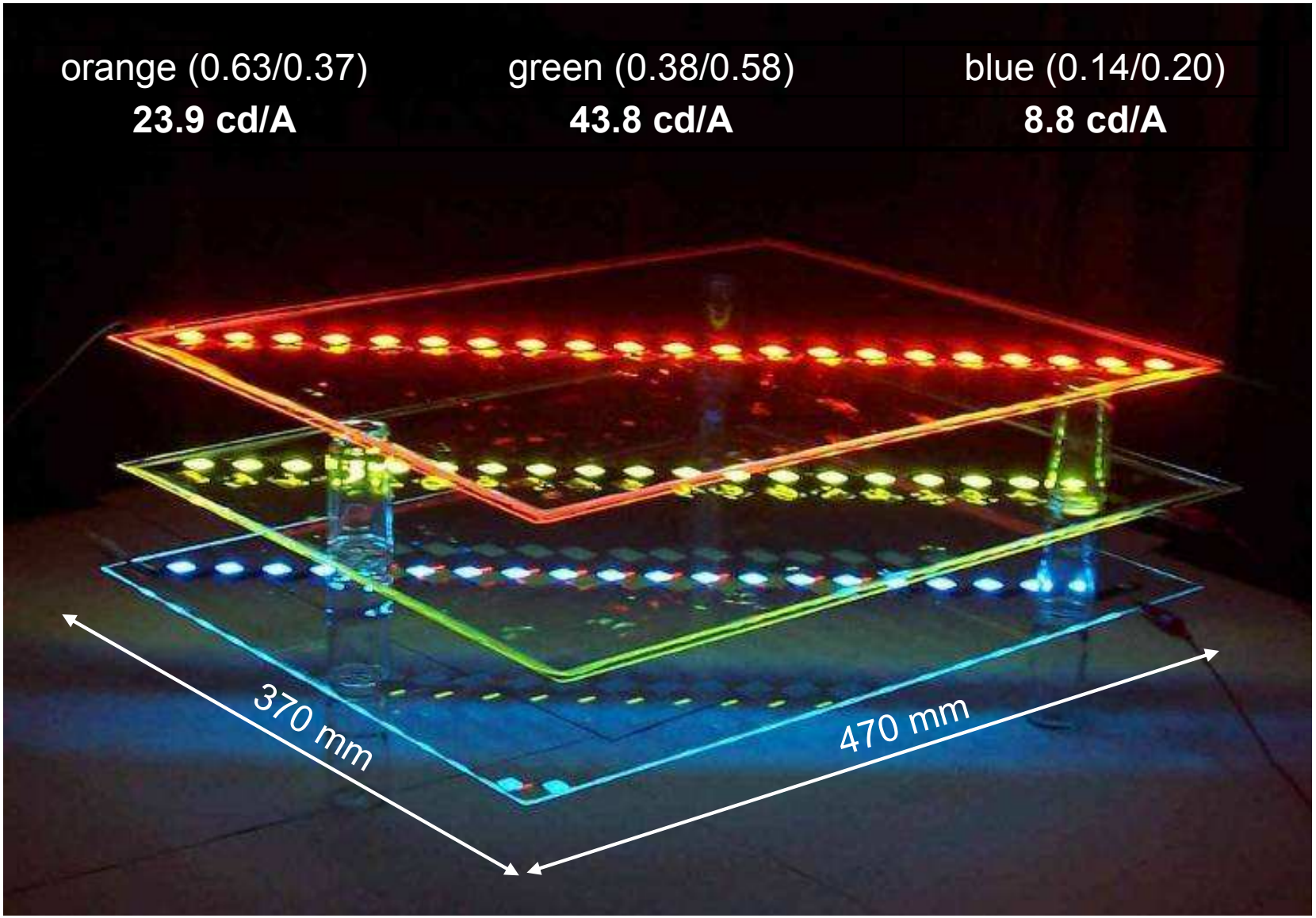
PILOT LINE FOR RIGID SUBSTRATES ON 370 x 470 MM²

OLED ON GEN2-SUBSTRATES - EFFICIENCY @ 1000 CD/M²



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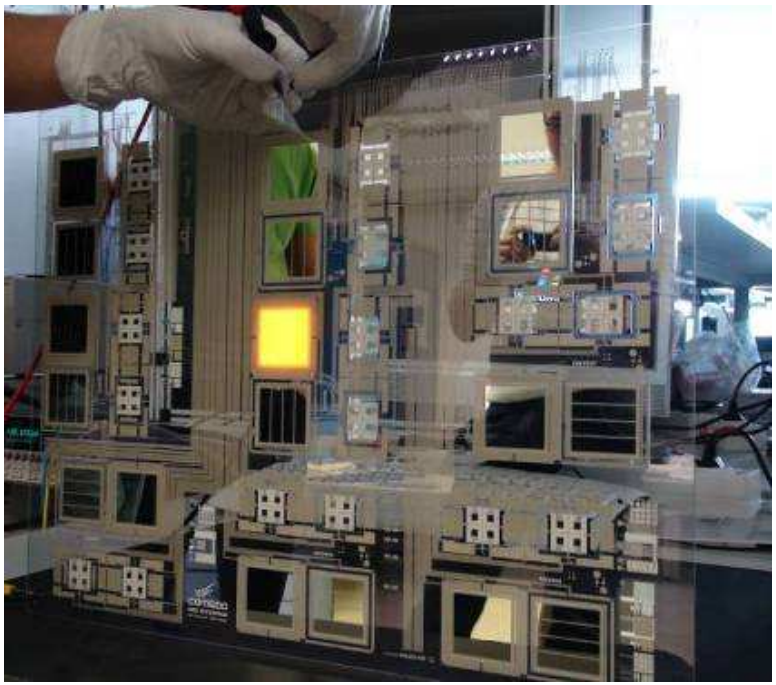
OLED ON PHOTOLITOGRAPHY FREE SUBSTRATES

Test Layout



Active OLED area up to 50x50 mm^2

Demonstrator SO-Light

Active OLED area 100x50 mm^2

Gen2 Substrates 470x370 mm2
Structuring by Screen Printing and Laser Ablation
Small Molecule Deposition by Thermal Evaporation

So Light

OLED 100.eu

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OLED SIGNAGE APPLICATIONS

OLED nameplate

OLED steering wheel

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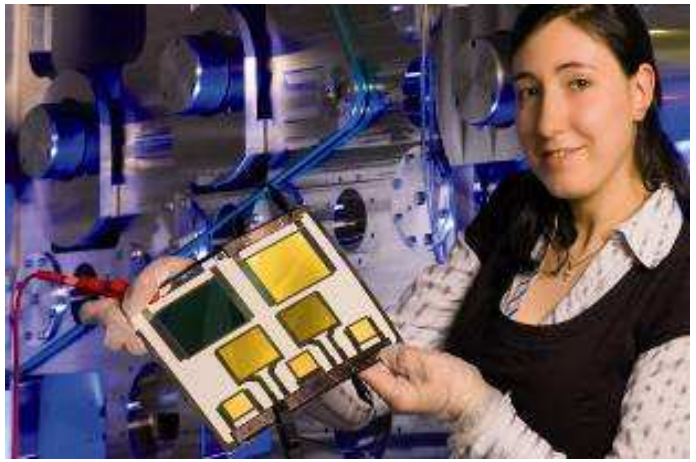
OLED ON FLEXIBLE METAL SUBSTRATES

New technologies for high efficient and simultaneously low-priced OLEDs needed to meet special requirements of general lighting market:

- Roll-to-roll-manufacturing
- Low-priced metal foil as substrate

Status at IPMS:

- Processing of metal sheets 200 x 200 mm² in cluster and inline system
- Installation of a R2R line



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ROLL TO ROLL VACUUM COATER ROLLEX 300

Winding unit

Deposition cylinder

Attachement possibility
for an inert shuttle

VON ARDENNE

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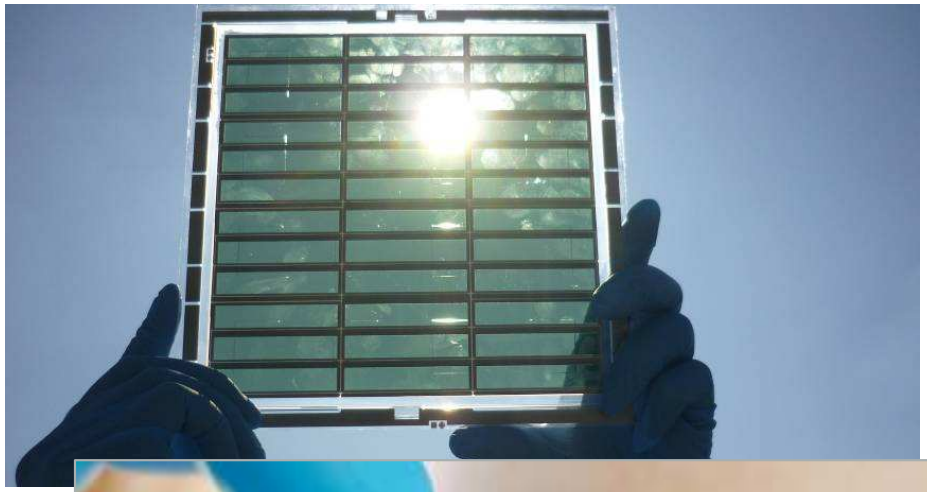
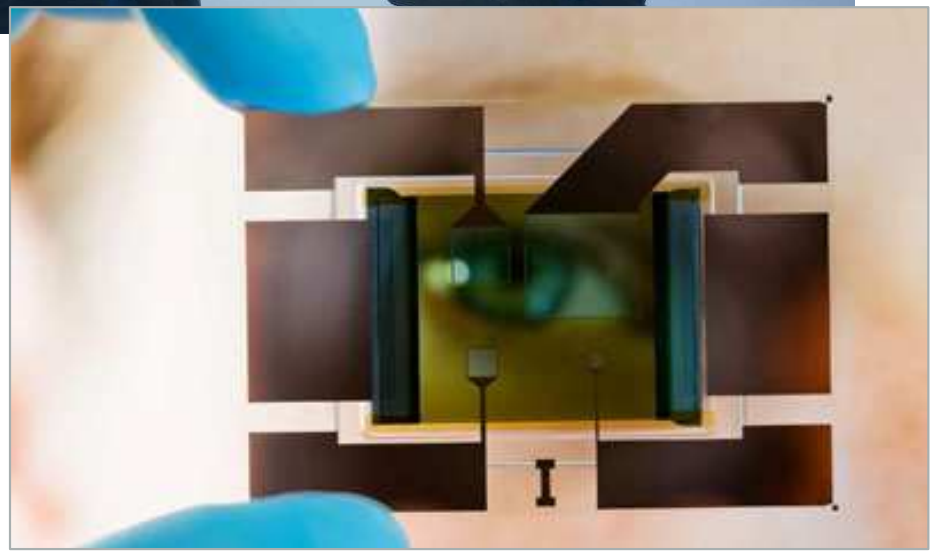
ORGANIC SOLAR CELLS





- Total thickness: < 1 µm
- Highly flexible
- High freedom in color and shape
- Only small amounts of org. materials are required (< 1g/m^2)
- Cost effective production due to close to room temperature processes
- Large area coating
- Production technologies similar to SM OLEDs
- Short energy payback time (~ 1 year (estimated))

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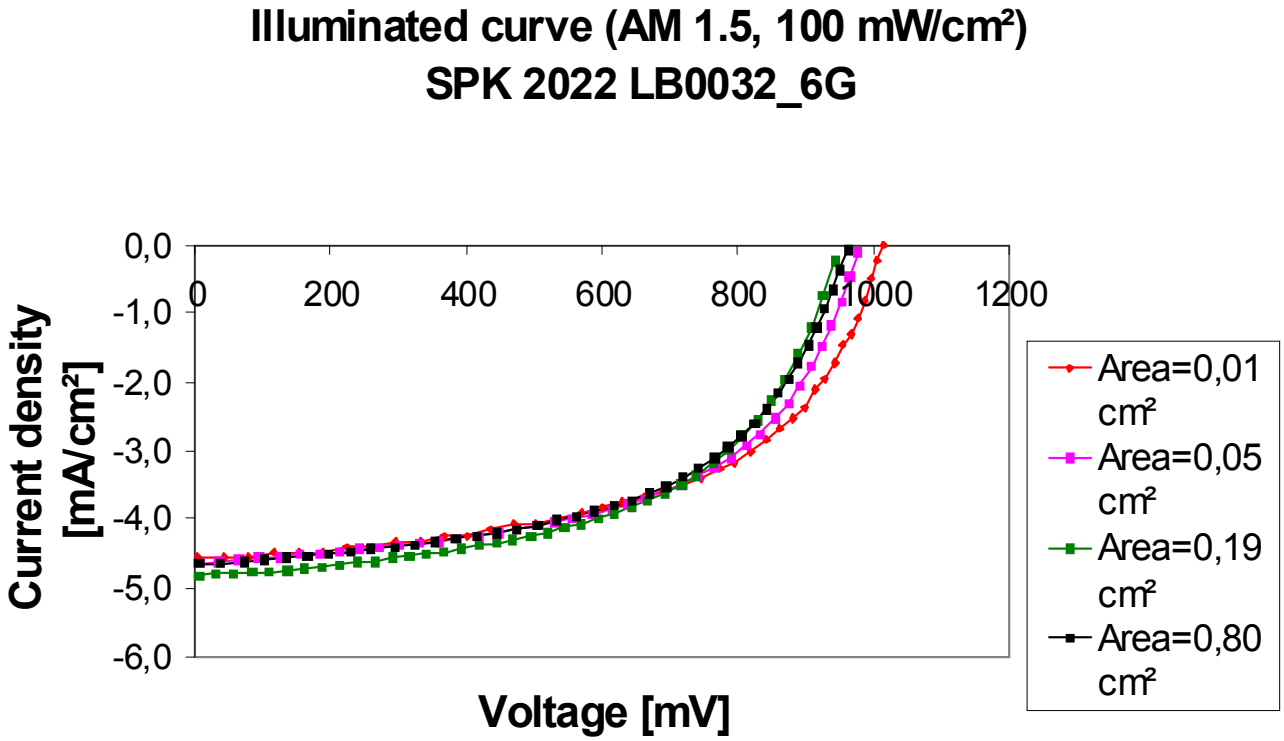
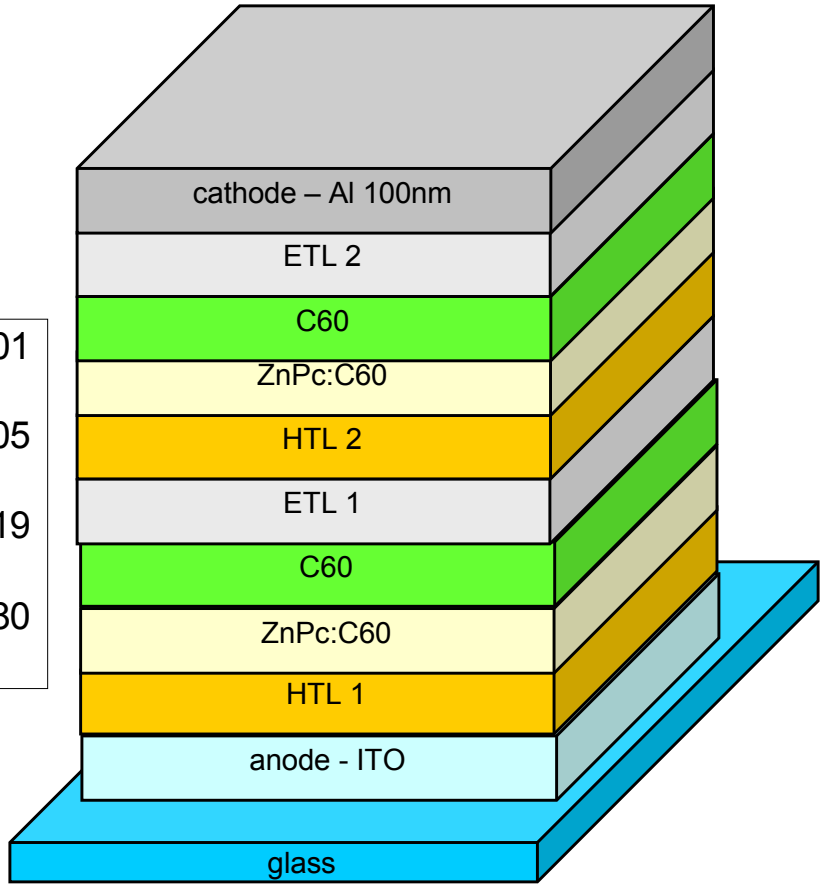
MODEL SYSTEM ZNPC:C60 TANDEM CELL



Area	Isc mA	Uoc mV	FF %	Eta %
0.01 cm²	0.06	1067	60.08	3.02
0.05 cm²	0.23	1061	60.54	3.00
0.19 cm²	0.93	1062	60.14	3.14
0.80 cm²	3.92	1072	59.66	3.14



Tandem PIN solar cell

Module efficiency 2.0 % (10 x 10 cm², monolithic serial connection)

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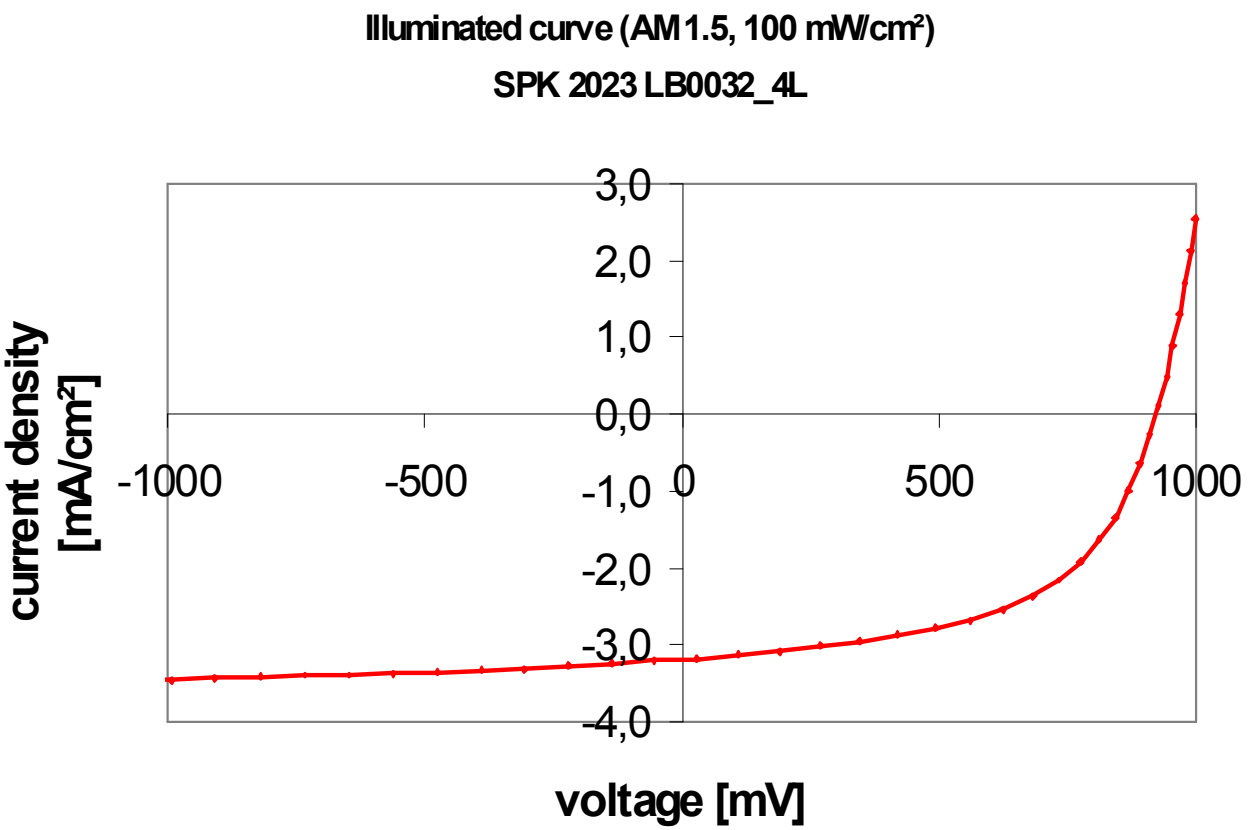
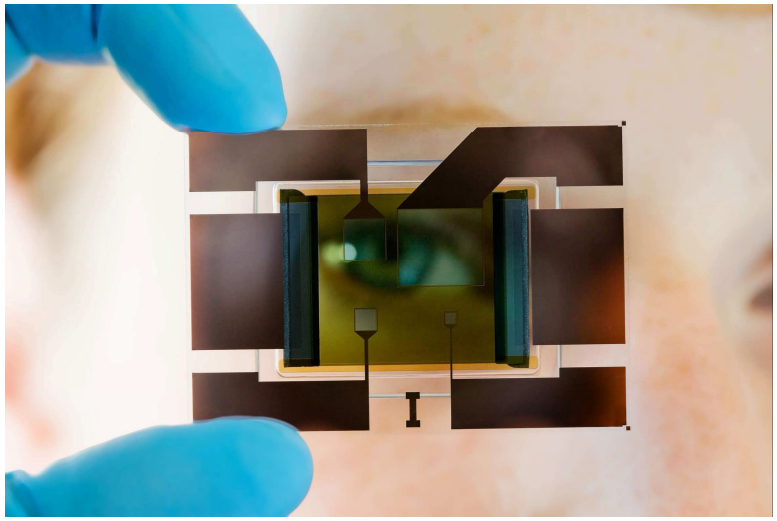
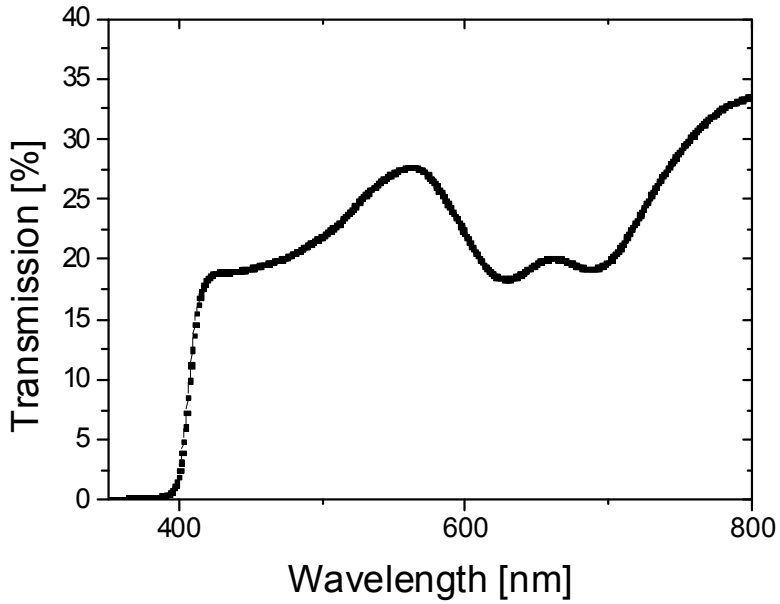
TRANSPARENT ORGANIC SOLAR CELL



U_{oc} =922 mV
J_{sc} = 3,5 mA/cm²
FF = 54,3 %
Eff = 1.8 %
Area= 0.19 cm²





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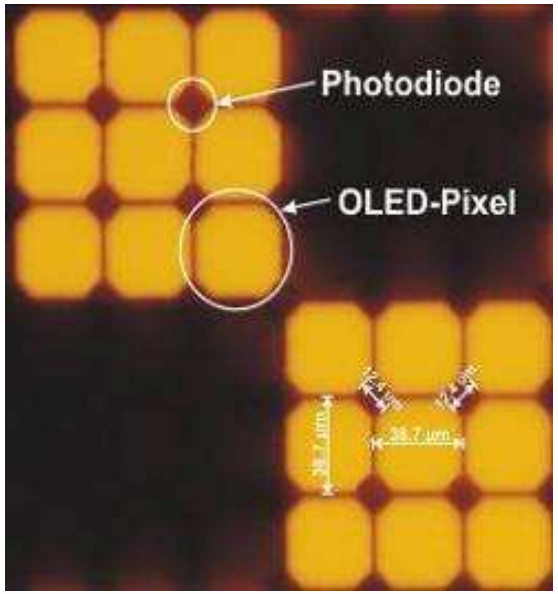
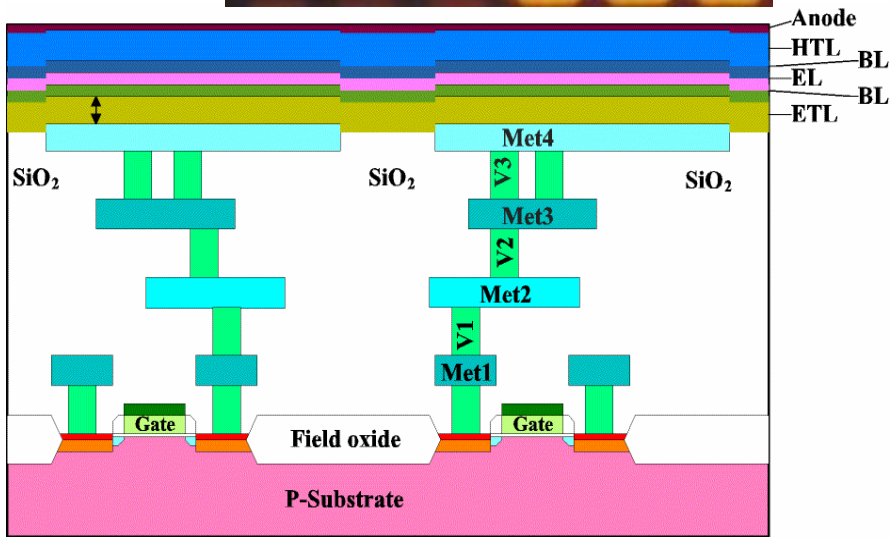
OLED-ON-CMOS

- highly-efficient OLED light source in/on CMOS
  - extremely thin (~100nm)
  - arbitrary shapes
  - all colors monochrome, white, NIR
  - excellent current/power efficiency (low-voltage, low-power)
  - good/improving lifetime (several 10kh)
  - self-emissive
  - fast response time (MHz)
- electronics feature integration
  - driving, acqusition, processing, control,...
- sensor co-integration
  - CMOS-compatible sensors (embedded photodetectors, temperature, magnetic (Hall)
  - M(O)EMS,...

OLED Cam test chip (0.35µm CMOS)
Active matrix OLED-Microdisplay





CMOS cross-section with OLED on top

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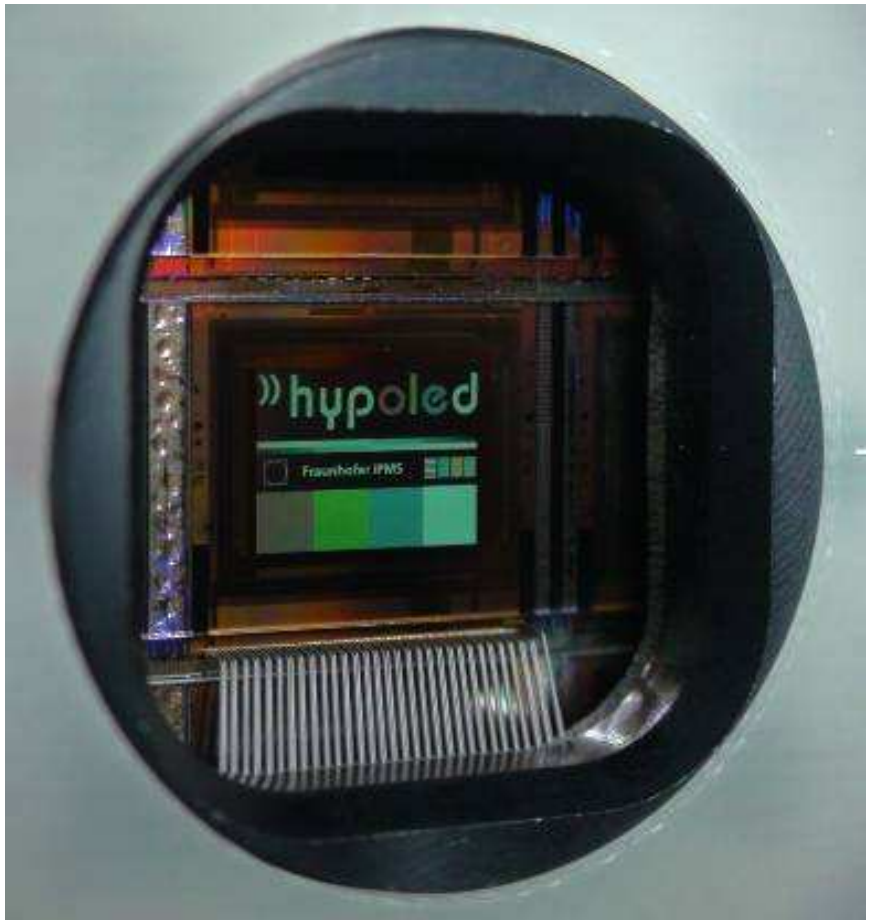
VGA OLED MICRODISPLAY

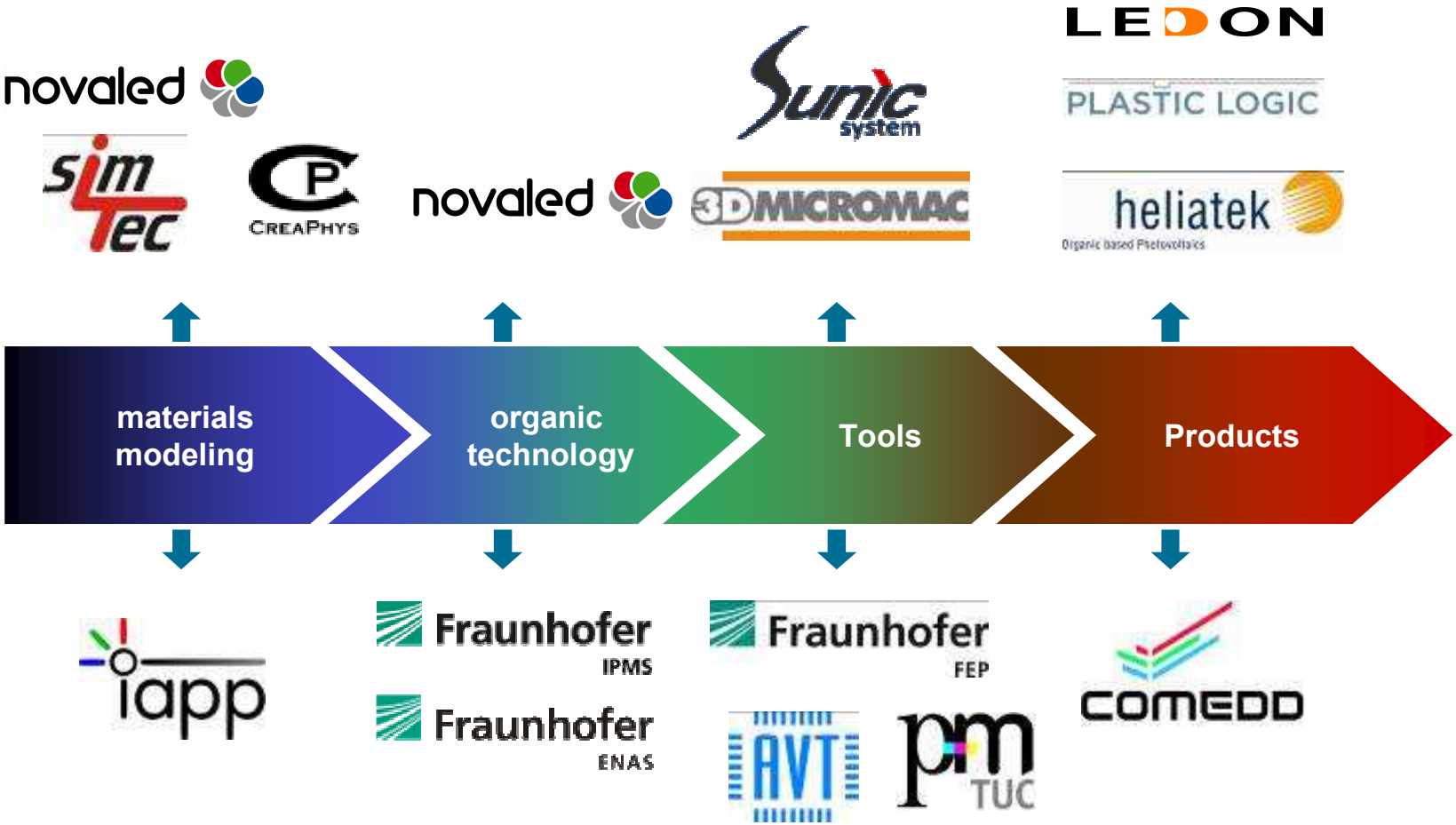
- colour VGA (640x480) OLED microdisplay
- active area 7.68 x 5.76 mm² (chip size 12 x 11 mm²)
- High brightness: 1,000 nits for RGB colour (HMD)

- see talk by M. Scholles,
  Friday, April 23th at MST Vision session



ORGANIC ELECTRONICS SAXONY

oes
Organic Electronics Saxony



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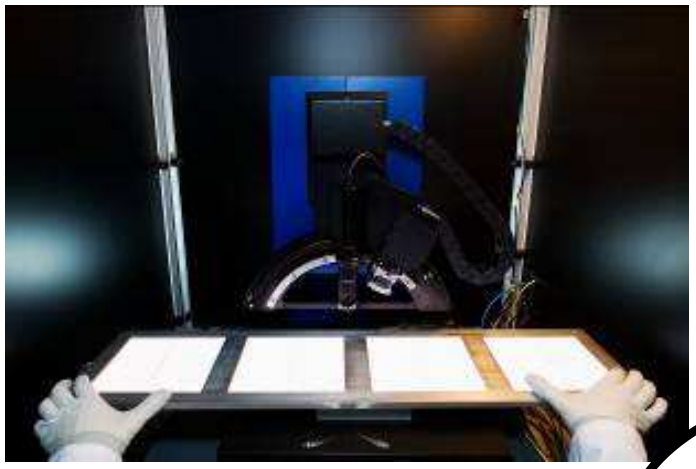
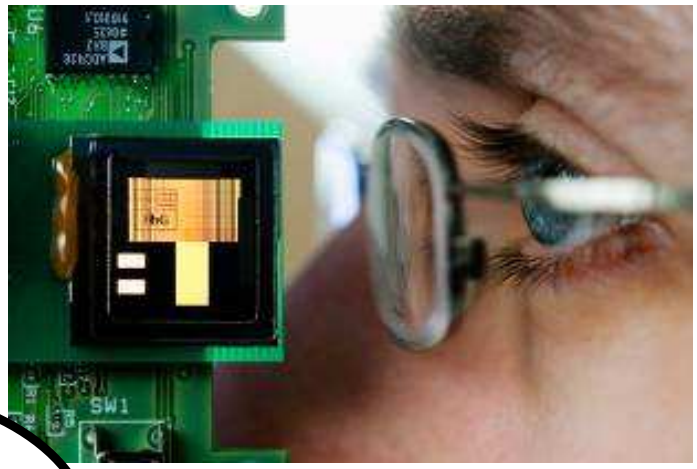


Fabrication technology



Integration technology

FOR ORGANIC DEVICES

Product related R&D

Pilot production

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COOPERATION OFFER

OLED allow the high efficient generation of light on several substrate types

COMEDD Gen2 pilot line is available from now

Metal strips and roll to roll deposition have the potential for low cost production of lighting devices

Further potential for OLED on CMOS on OPV application as well

COMEDD @ Fraunhofer IPMS wants to be your partner for research, development and pilot fabrication in this novel device technology area.

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Thank you for your attention!

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We shape the light.