

## Optical Sensor Platform By Modular Assembly of Organic Electronic Devices:

### *Towards a Smart Bandage*

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- **Proof of principle**
- **Conclusions**

## Holst Centre: Concept

- Creating generic technologies, time to market 3..10 years
- Partnering with industry and universities
- Open innovation through precompetitive shared programs
- Critical mass: currently over 150 researchers, residents and staff



## System-in-foil Program Line

Aim:

- The development of cost effective advanced flexible electronic devices
  - R2R technology, low cost materials and processes
  - Device design

Examples of current developments:

- Organic lighting and signage devices (flexible OLED's)
- Flexible sensor tags and systems



OLED signage

Flexible 'smart bandage'

Smart Blister

## Smart Bandage: In Plane Optical Sensor Platform

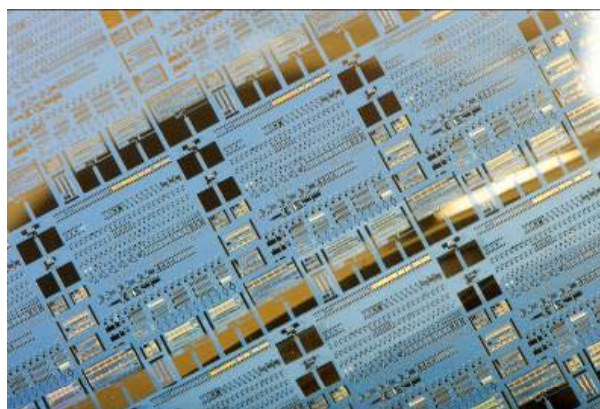
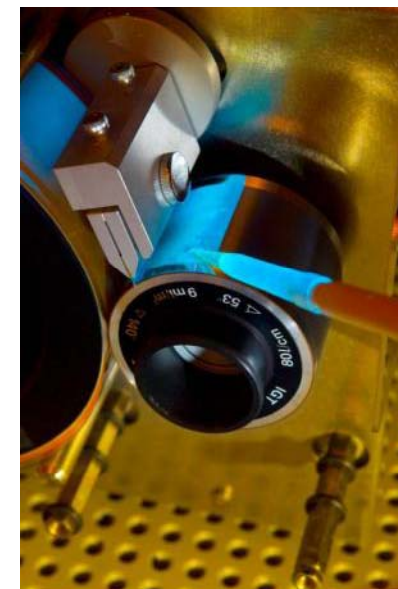
- **Smart bandage**
  - Bandage with monitor function
  - Avoid infections, wound damage
- **Organic devices**
  - Thin; Light weight; Cheap; Bendable
  - Manufacturing on foil
- **Many possible targets**
  - Healthcare
  - Agro/food
  - Defense and safety





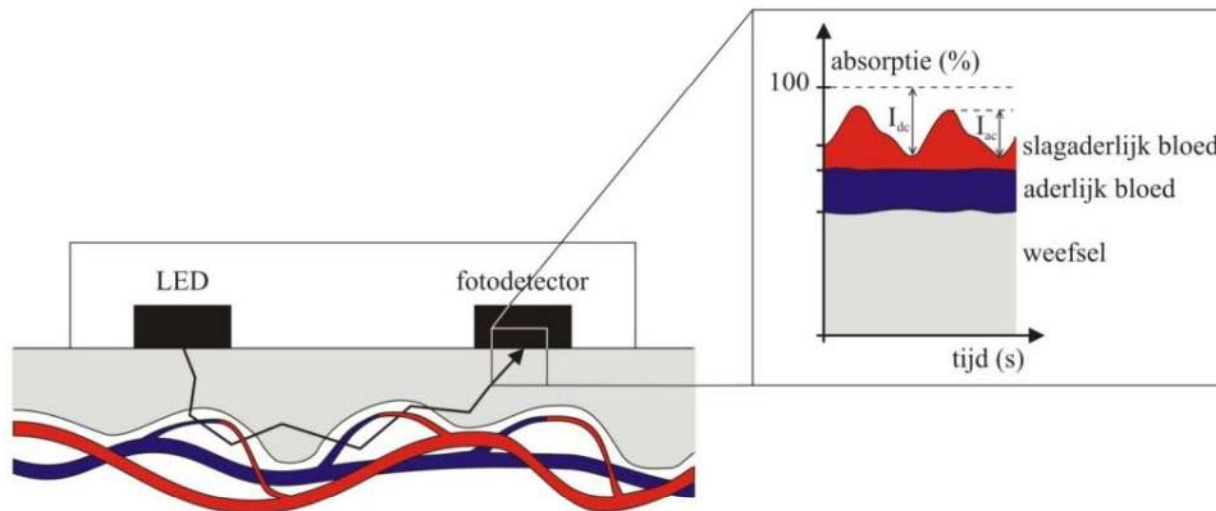
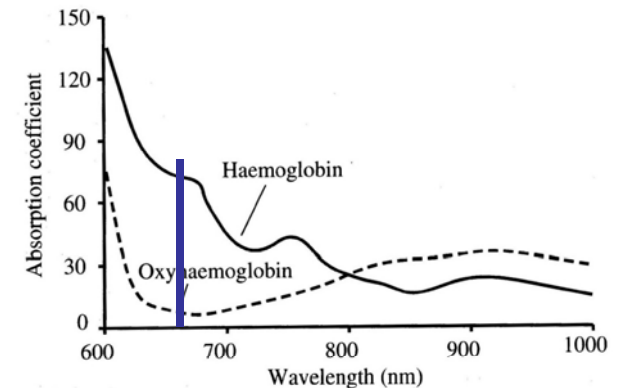
## Platform of Holst Technology

- Printing LEP and PV blends
- Barrier foils
- Foil integration
- Printed contact lines
- Organic driving and readout circuitry
- Lithography on foil
- Low power micro electronics (WATS)



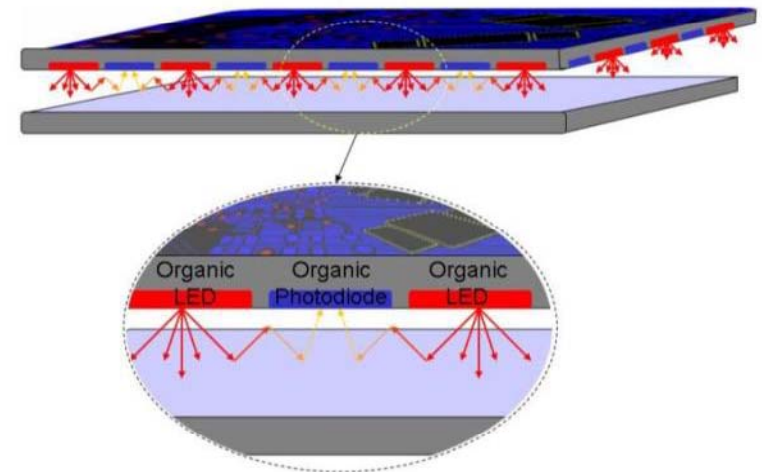
## Wound monitoring: Survival of the flap

- **Optically monitoring perfusion in wound area**
- **Pulse-Oximeter in reflection**
  - Measure expansion of arteries (pulse)
  - Measure color of blood (oxygen saturation)



## Test case: Pulse-oximeter in Foil

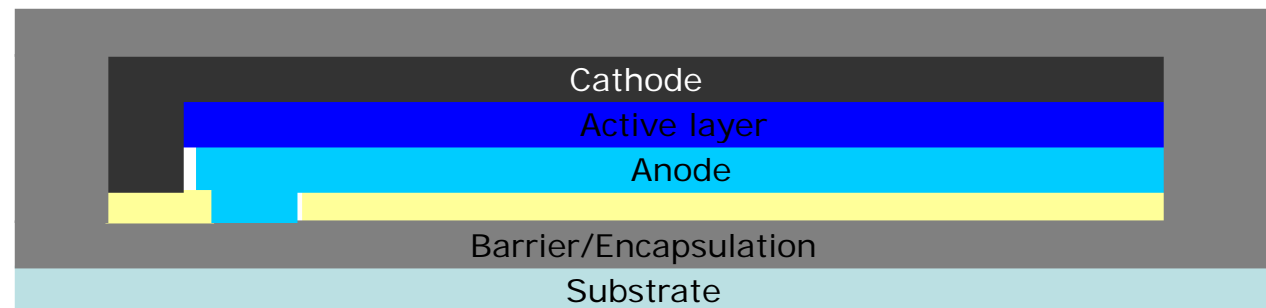
- **1<sup>st</sup> stage: pulse meter**
  - One wavelength
- **2<sup>nd</sup> stage pulse-oximeter**
  - 2 wavelengths: red 660 nm, NIR 800/900 nm
- **Photodiodes and Leds in same plane: printing required**
- **Electronics**
  - Led driving
  - Diode readout Si or organic
  - Integration of Si in Foil Technology
  - Ultimately in a body area network





## Design

- **Glass**
  - Double side processing
- **Foil**
  - Modular: diodes and LEDs manufactured on separate foils
- **Top emissive PLEDs**
- **Bottom receptive OPDs**



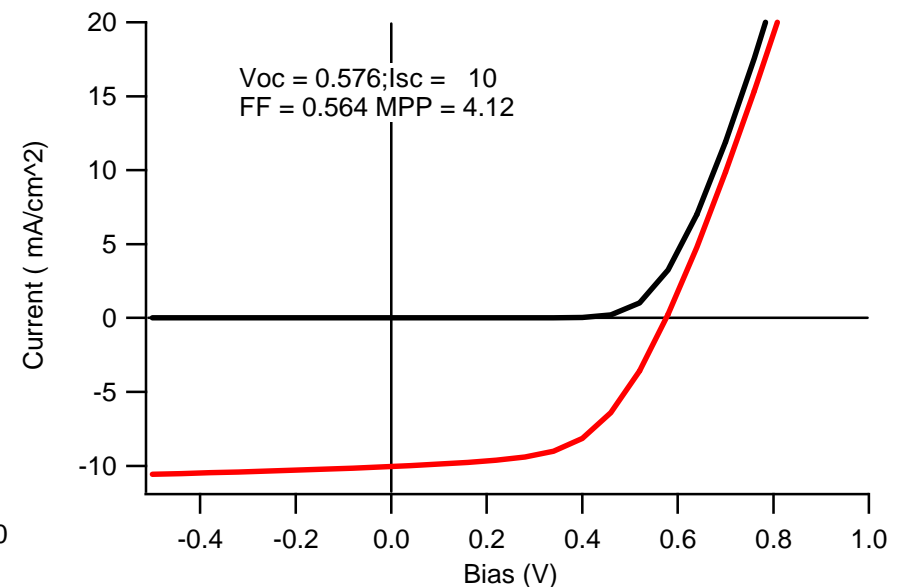
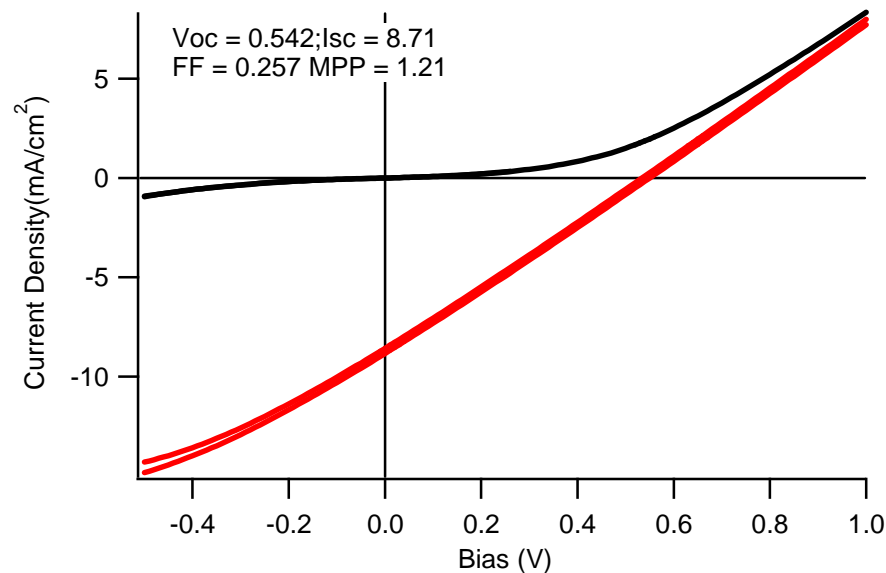
# Printing

- **Diode**
  - P3HT/PCBM ratio 1:1 – 1:4
  - high spectral response over broad range
  - Forgiving:  
layer thickness 100-200 nm
  - High boiling solvents give improved efficiency
- **LED**
  - Merck Red (Gen 1)



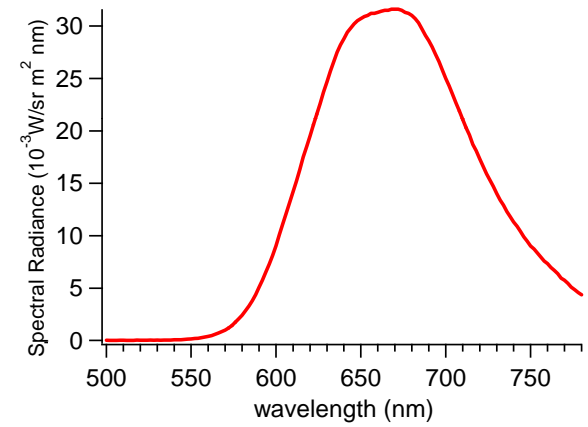
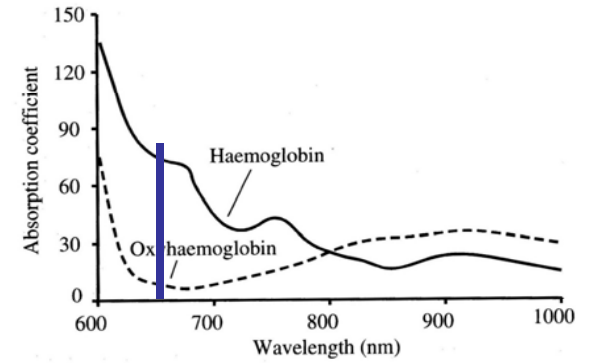
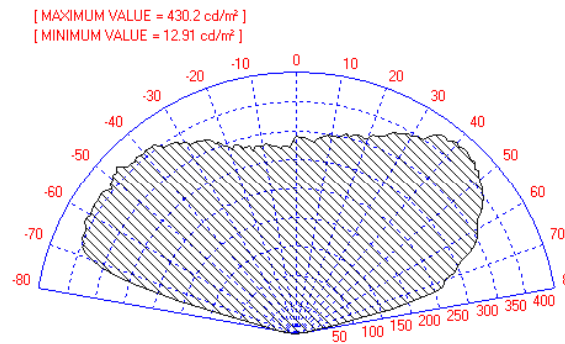
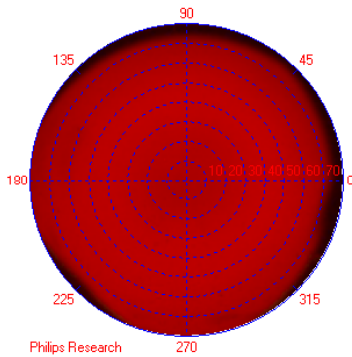
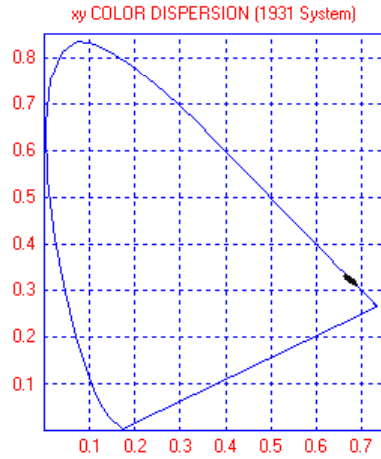
## Printed Photodiodes

- **All printed device**
  - Pedot and active layer (ink 1)
- **High Currents**
- **High leakage current** → homogeneity not yet optimal
- **Layer thickness: 150-450 nm (freestanding)**



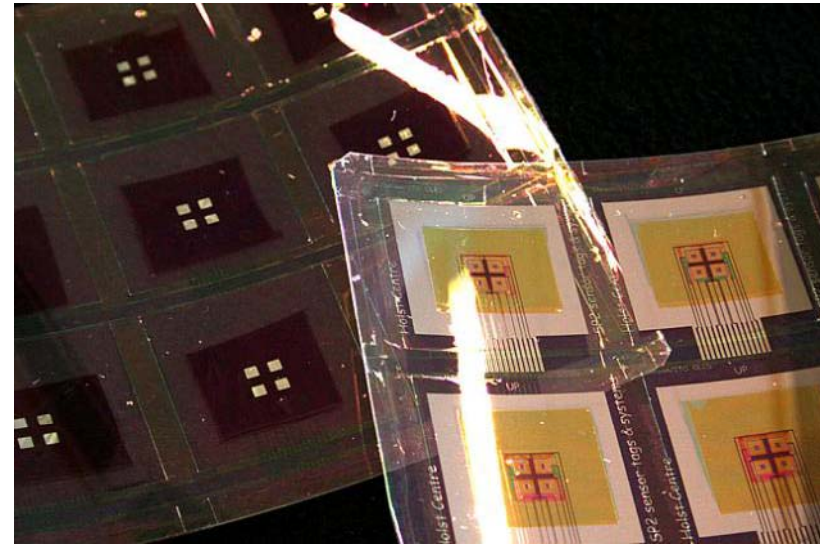
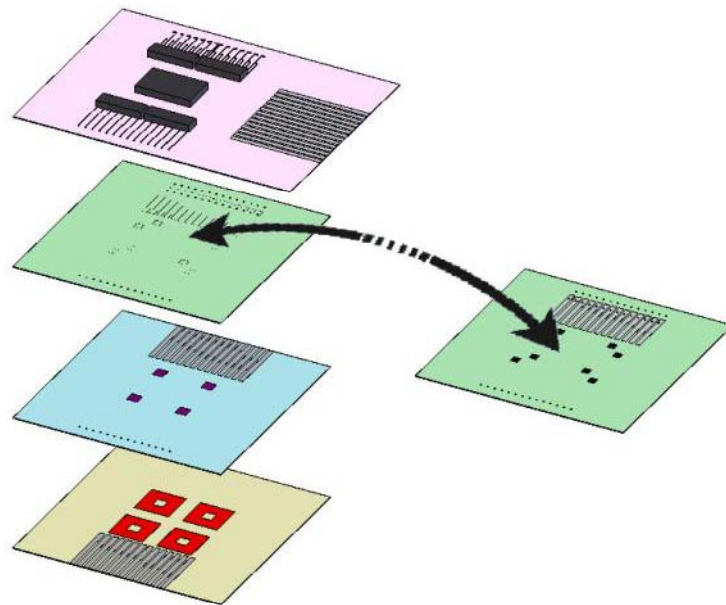
# Top emitting PLEDs

- Red emitting material (Merck Gen 1)



## Foil Integration

- Modular approach



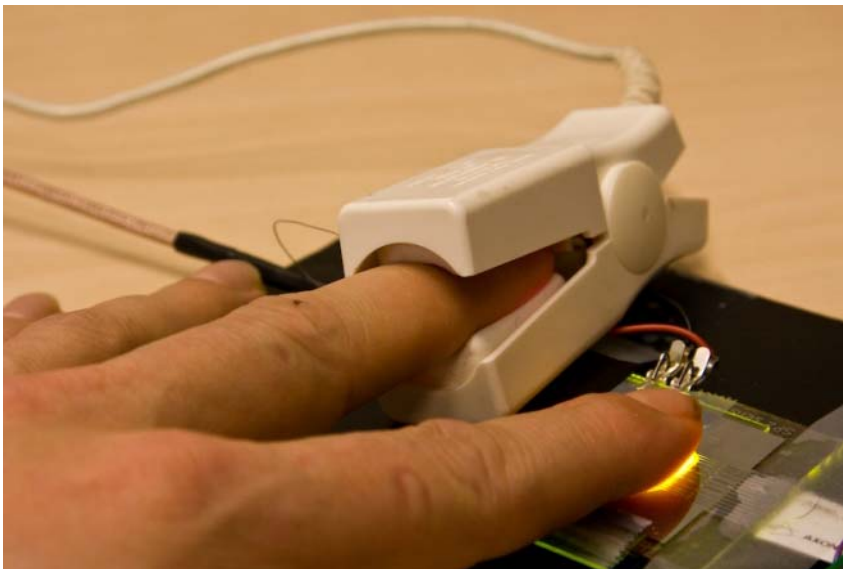
- **Electronics**
  - Logarithmic amplification (AD8305aru)
  - DC filtering
  - Noise filtering 0.5-15Hz
  - Continuous driving and read out



## First all Organic Prototype: Proof of Principle

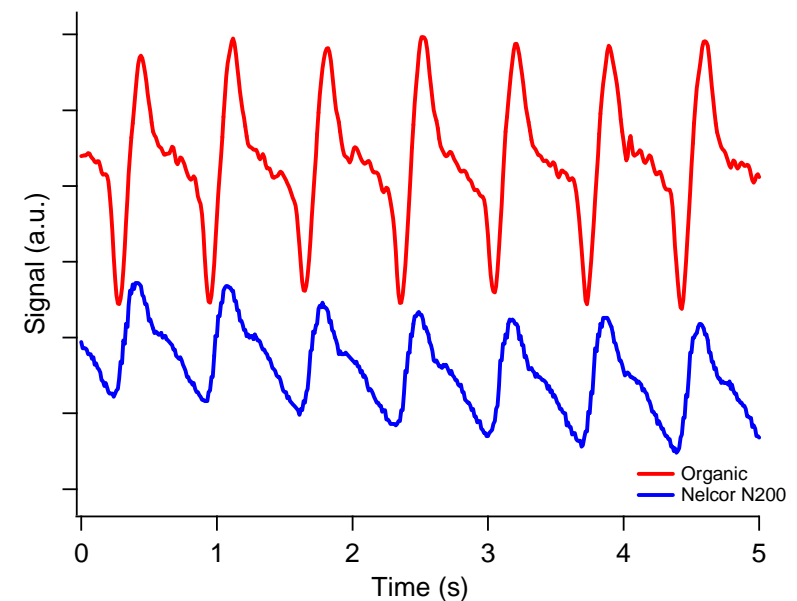
- **Signal**

- DC signal ca. 10  $\mu$ A
- AC signal ca. 50 nA
- S/N  $\sim$ 10 (AC)



- **Works!**

- PPG comparable to commercial pulse-oximeter (Nelcor N200)
- Heat generation
- Higher efficiency emitter needed



## Resume

- **In plane optical sensor array**
  - Pulse meter realized
    - Organic sensor Node
    - Fabrication technology
    - Integration technology
  - Platform for other applications
  - Integration of organic and classic technology
- **Short Term Outlook**
  - Optimize with more efficient materials
  - Optimize printing strategies
  - Integrate organic read-out foil



# Acknowledgements

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  - Smart Bandage Team:  
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## Reaching out to cooperate



### **Benefits of Joining the Holst Center**

- Access to relevant Holst background IP & Knowhow
- Joint Development Programs with Industrial Partners
- Facility & Cost sharing