

# Clevios™ a Highly Conductive Polymer for Transparent Electrodes

Andreas Elschner

Heraeus Precious Metals – Conductive Polymers Division, Leverkusen, Germany

## The Heraeus Group at a Snapshot

- We are a global **precious metals and technology Group** with firm roots in Germany. The company has been **family-owned** for more than 155 years.
- Precious metals, sensors, biomaterials and medical products, dental products, quartz glass, and specialty light sources are the focus of our activities.
- In 2011, we generated **€4.8 billion in product revenue** and **€21 billion in precious metals trading revenue** with about 13,300 employees in over 120 subsidiaries.

## Thanks to Heraeus, the World has changed ...



... use and communicate via the internet due to fiber glass cables all over the world.



... more than telephone thanks to modern microchips within our mobile phones.



... support environmentally friendly solar power production to make solar cells more efficient.



... entrust a platinum temperature sensor with our food.



... drink potable water purified by UV-sterilization lamps.



... produce fertilizers with the help of platinum gauzes.

## isolators, conductive polymers, metals



**classic polymers**  
 $10^{-18} - 10^{-16} \text{ S/cm}$



**CLEVIOS™ (PEDOT:PSS)**  
 $10^{-4} - 10^3 \text{ S/cm}$

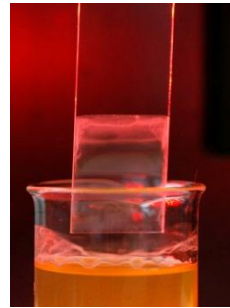


**copper**  $10^6 \text{ S/cm}$

## Application prerequisite: Processability



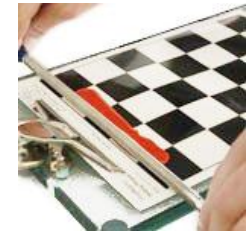
spincoating



dip coating



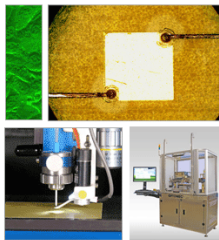
spraying



doctor blading



slot-die coating

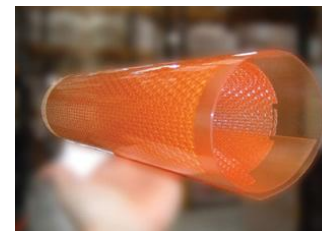


Optomec Aerosol Jet systems

aerosol jetting



screenprinting



flexo printing



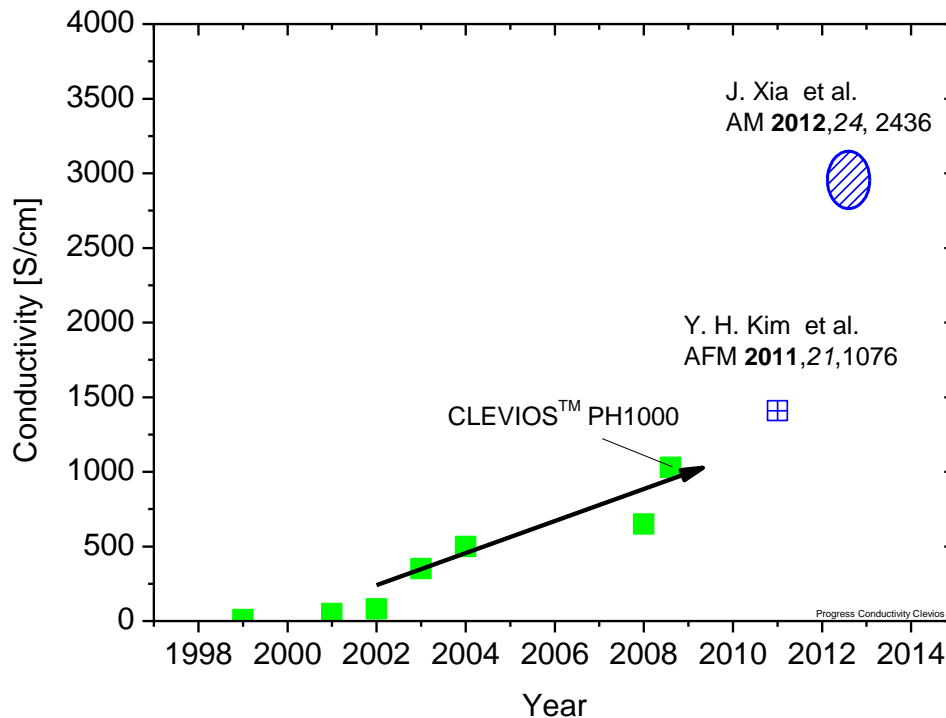
gravure printing



inkjet printing

# CLEVIOS™

## Progress on Conductivity

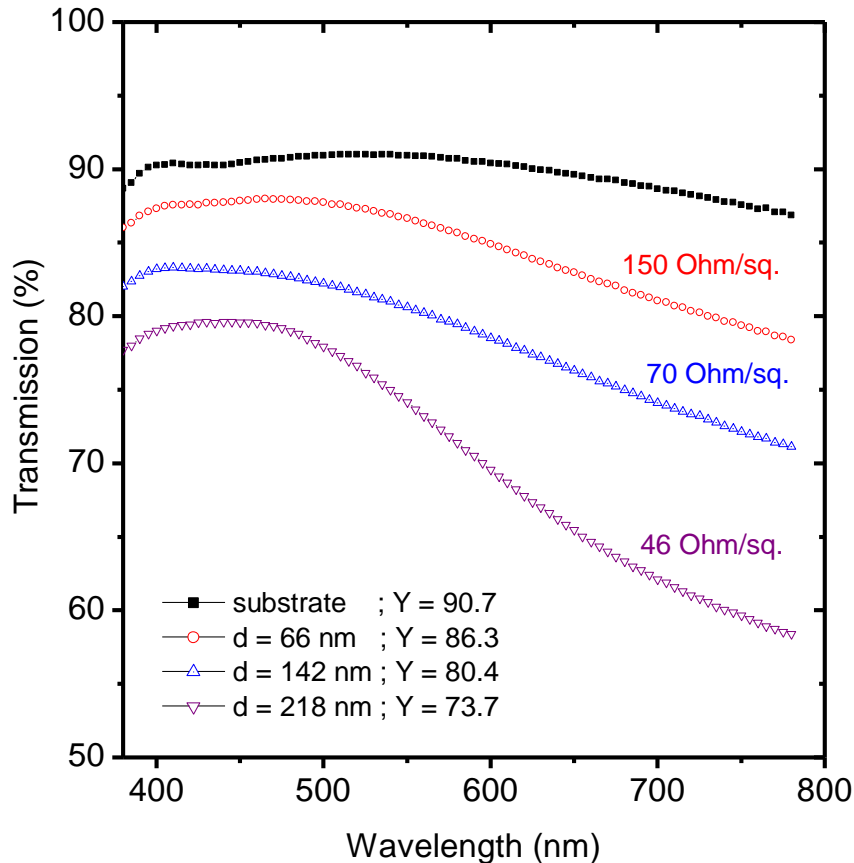


Post-treatment of PEDOT:PSS-films improves conductivity by:

- removing excess PSS
- modifying film's morphology

➔ Further progress on Clevios conductivity is possible

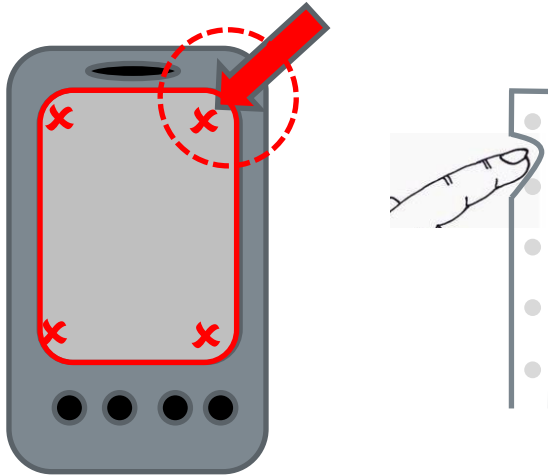
# CLEVIOS™ PH 1000 – Optical Properties



High transparency in visible!

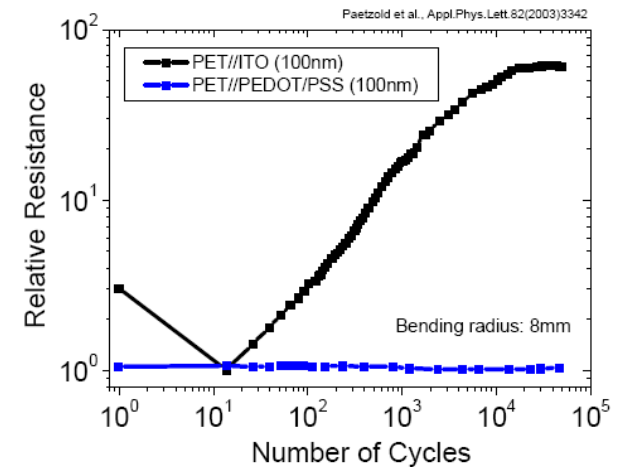
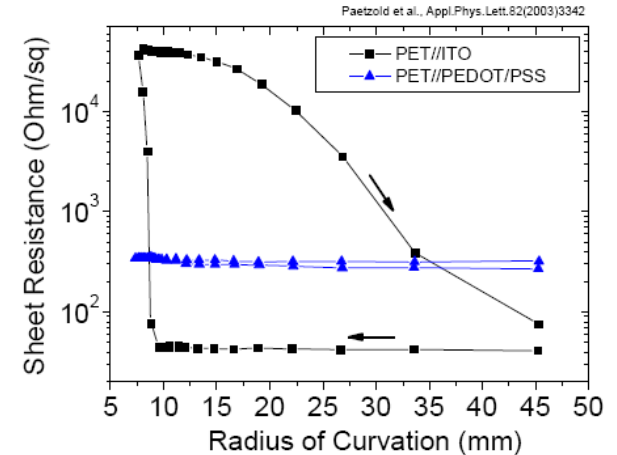
$$R_{sh} = \frac{1}{\sigma \cdot d} \iff \frac{T}{T_0} = \exp(-\alpha \cdot d)$$

## Example: Clevios™ F ET on PET film



High mechanical stress at edges and corners,  
(small-sized displays)

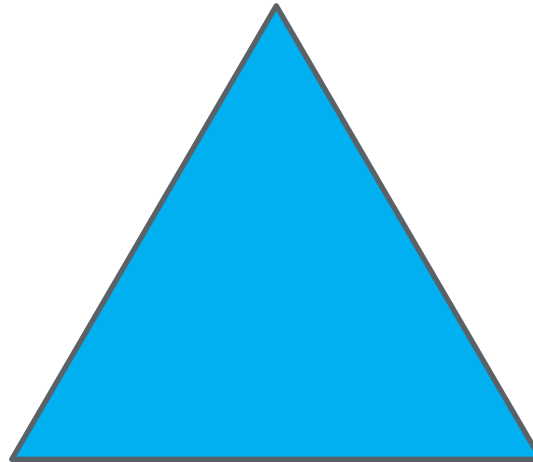
→ **Risk of ITO Cracking**





# CLEVIOS™: combination of properties

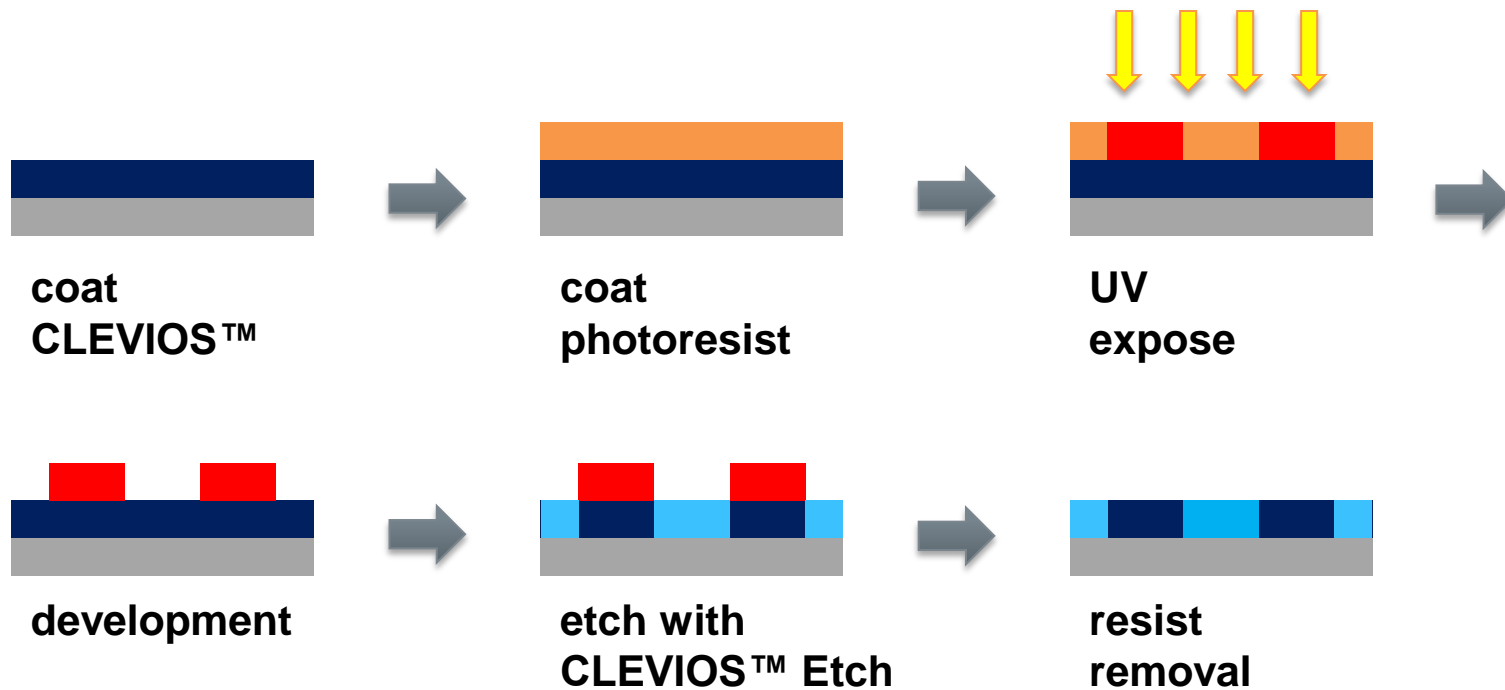
**conductivity  
up to 1.000 S/cm**



**transmission  
>85% in VIS**

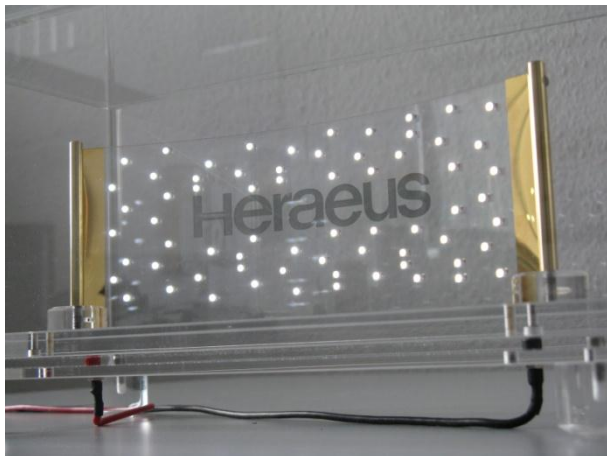
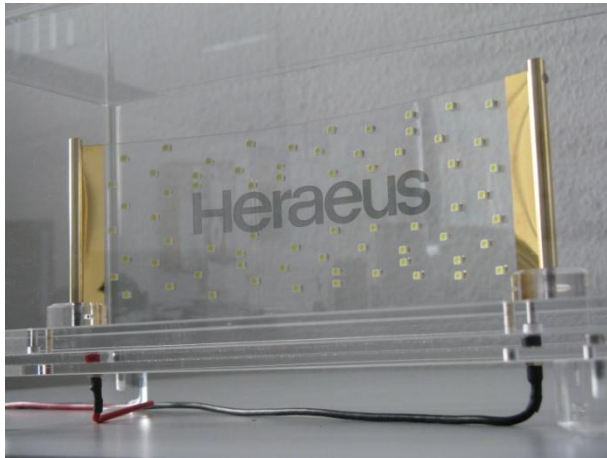
**flexibility >>50.000  
bending cycles**

# CLEVIOS™ Etch: wet etching process



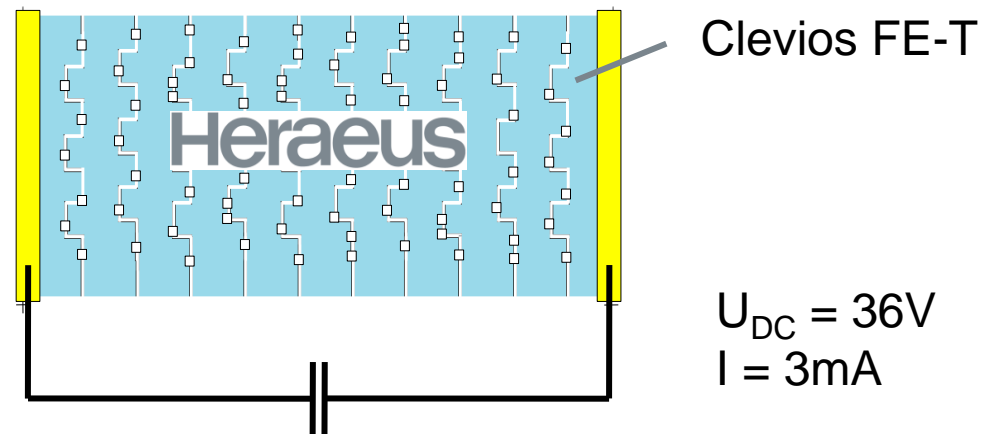
non-conductive  
 conductive

## Addressing Lighting!



### Enabling transparent wire free LED-lighting

A **Clevios FE-T** coated curved PET-substrate has been structured into strips using **Clevios Etch**. The non-conductive and conductive areas have the same transparent appearance. The adjacent conductive segments are electrically bridged by LEDs. The result is clear illumination, with no apparent electrical connections.



### Advantages:

- Invisible structure
- Flexible
- Long term stability

Thank you for listening

Come and visit our booth  
# 742

Internet: [WWW.CLEVIOS.COM](http://WWW.CLEVIOS.COM)