Neuromorphic Computing and Water & Energy Sustainability

Environmentally Stable and highly Conductive Organic Transparent Electrodes Laminated with Graphene

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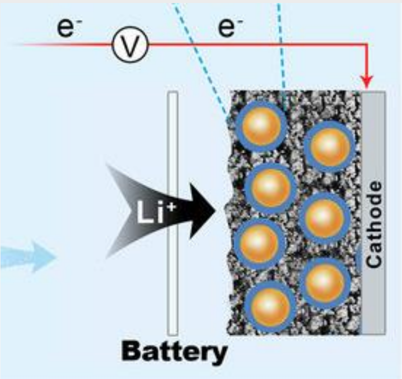
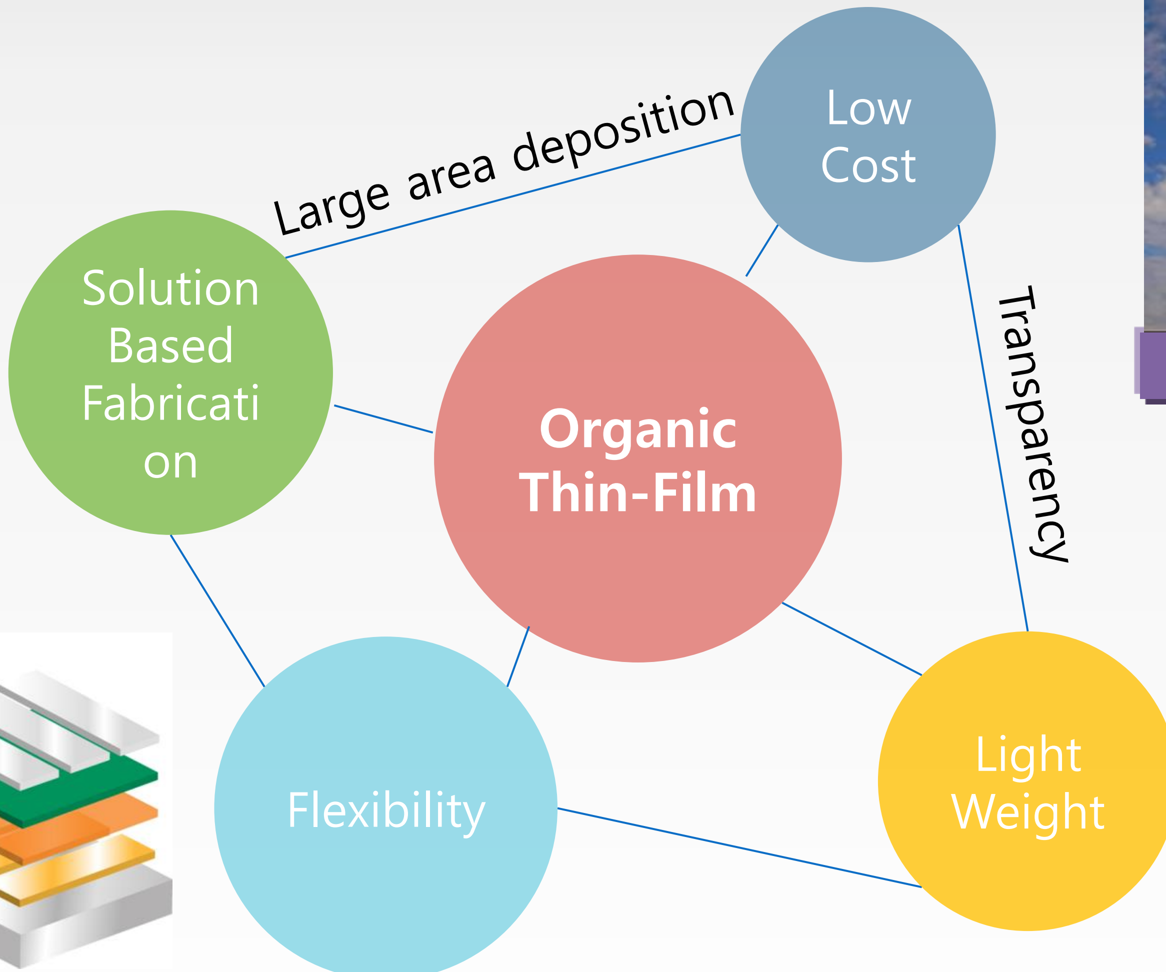
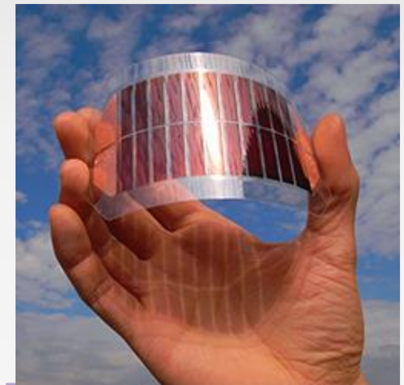
Conjugated Polymer Materials

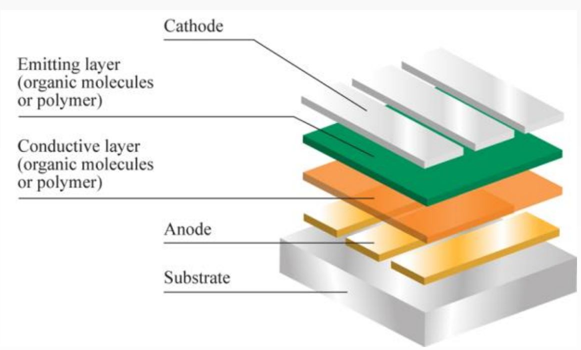


Li – ion Battery

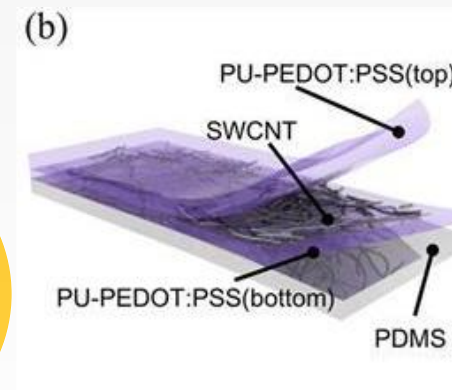




Solar Cells



OLED

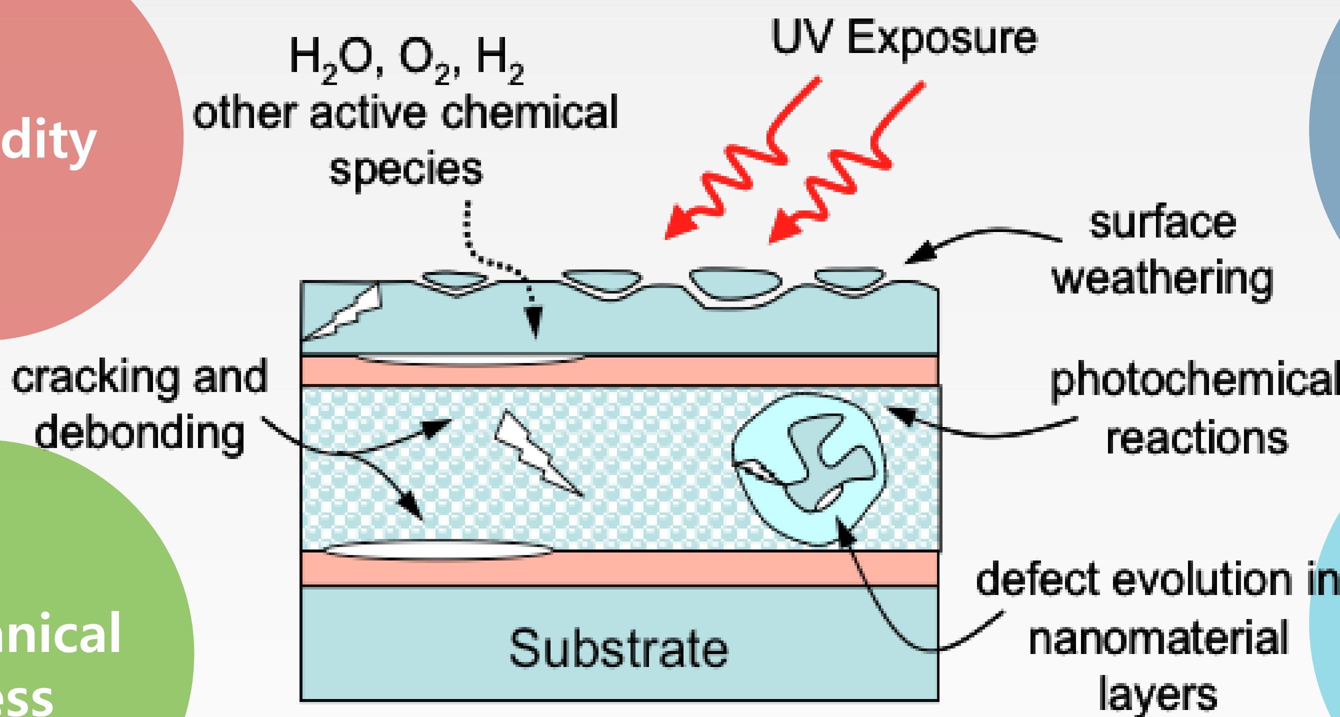


Actuator

Environmental degradation of organic film

Humidity

Thermal Degradation



Mechanical Stress

UV Exposure

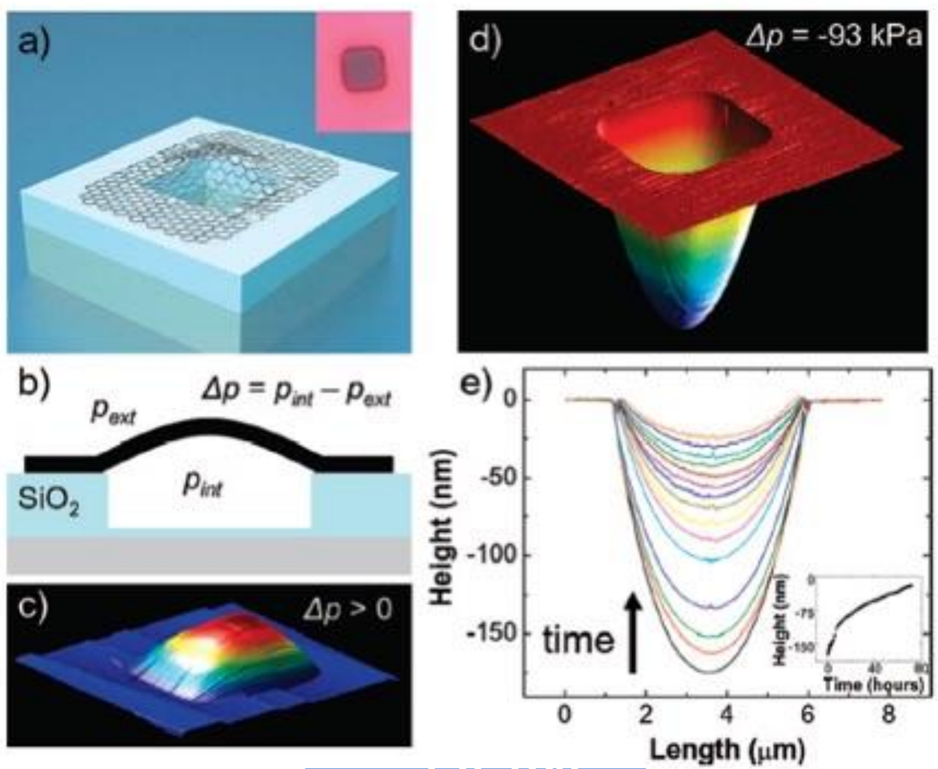
Performance▽ **Life time ▽** **Sustainability▽**

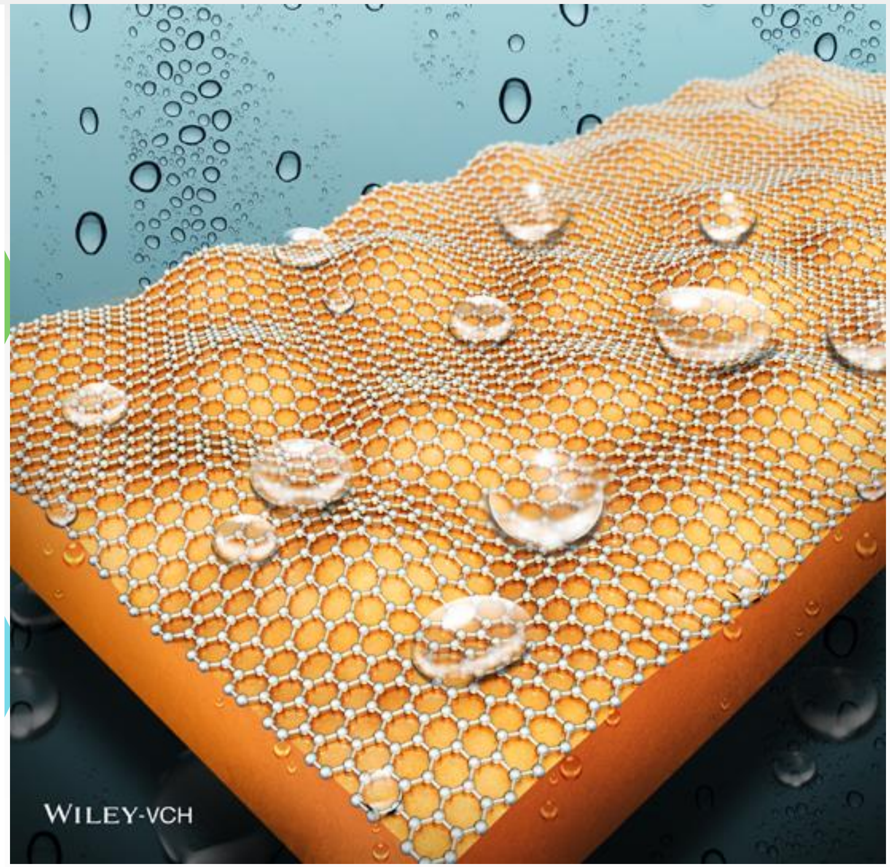
02. Innovative Idea

Impermeability of graphene

Gas Impermeability of any gases

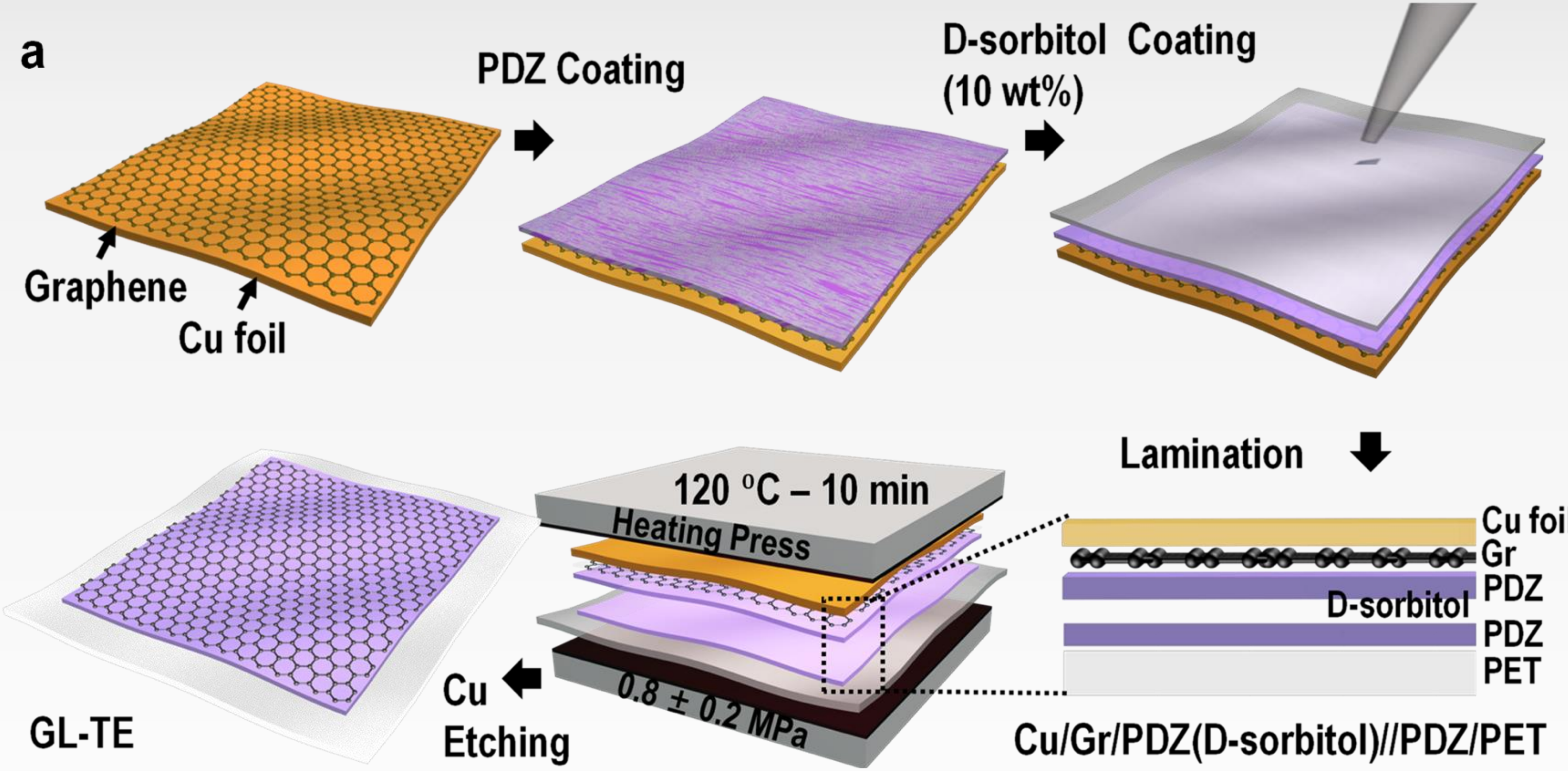
Nano Lett 2008, 8(8): 2458-2462.





Graphene layer used protective means

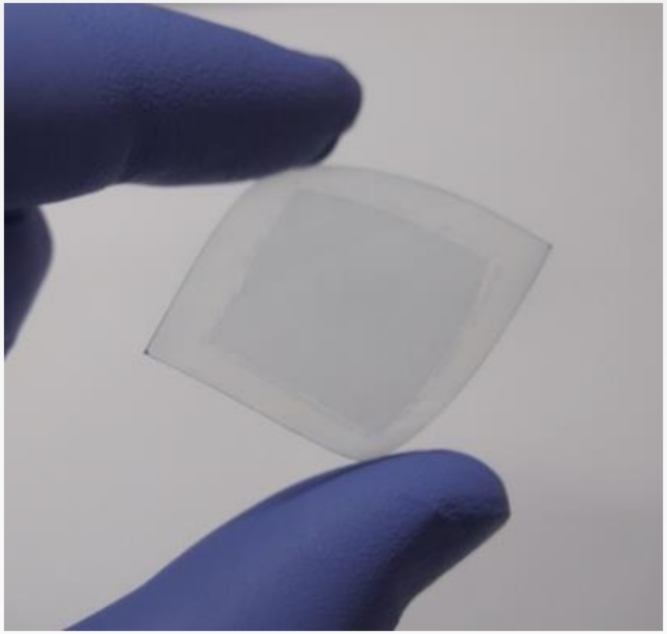
Highly conductive PEDOT:PSS with graphene barrier



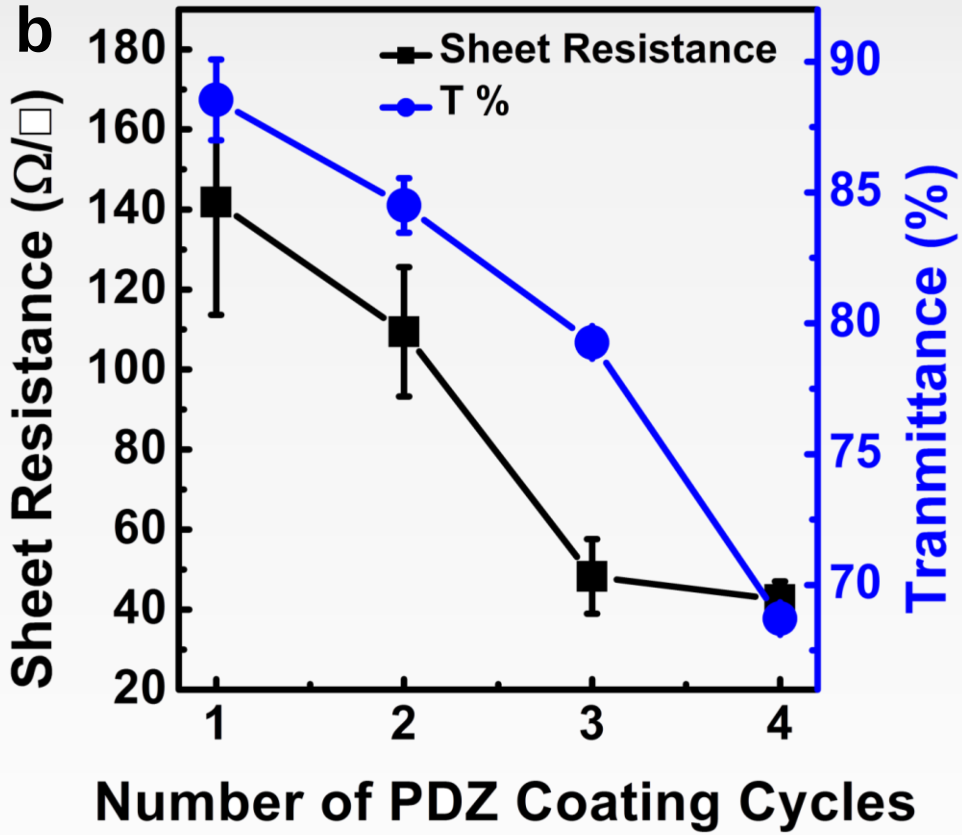
- **PDZ: A mixture of PEDOT:PSS (Clevios PH 1000), 5 wt% DMSO, and 0.05 wt% Zonyl**
- **GL-TE: Graphene Laminated Transparent Electrode**
- **Graphene-PDZ assembly layer can be directly laminated on PET substrate.**

Highly conductive PEDOT:PSS with graphene barrier

a Flexible GL-TE film



b

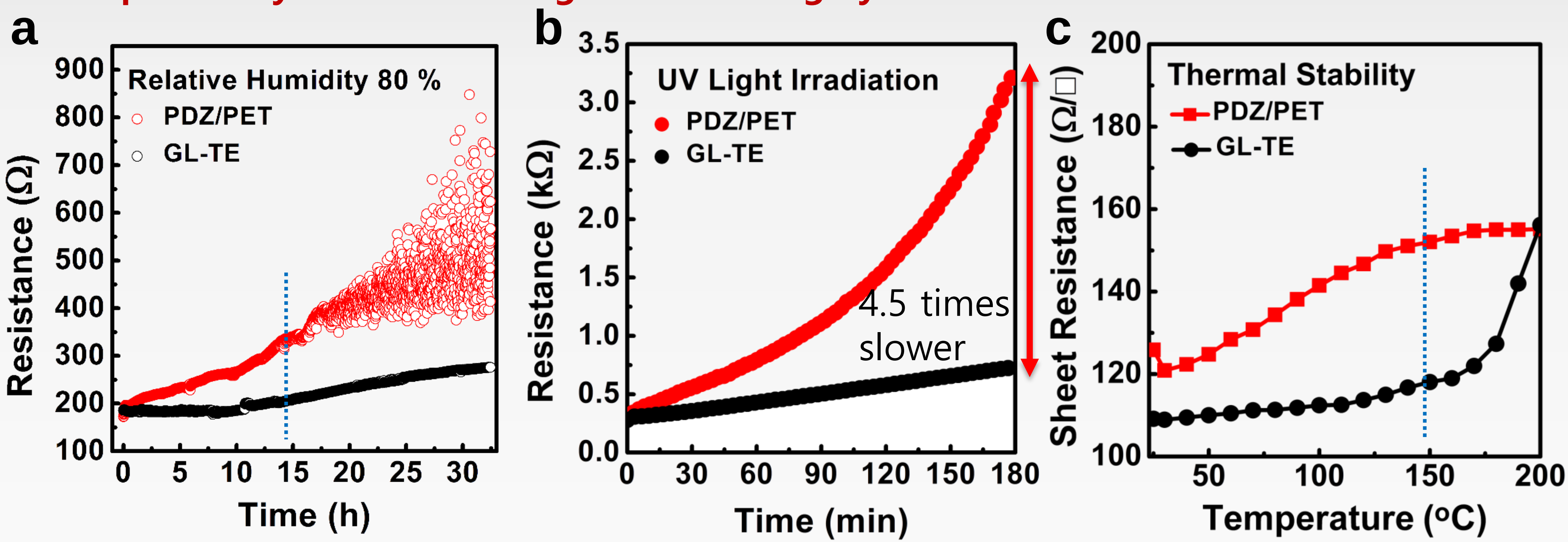


a) Photograph of as-synthesized, flexible GL-TE film (Transparency & large area dep.)
b) Sheet resistance (black squares) and transmittance at 550 nm (gray circles) of GL-TEs as a function of the number of PDZ coating cycles.

04. Characterization of GL-TE

Stability tests under unfavorable environmental agents

- **Graphene layer can be acting as role of highly effective environmental barrier**



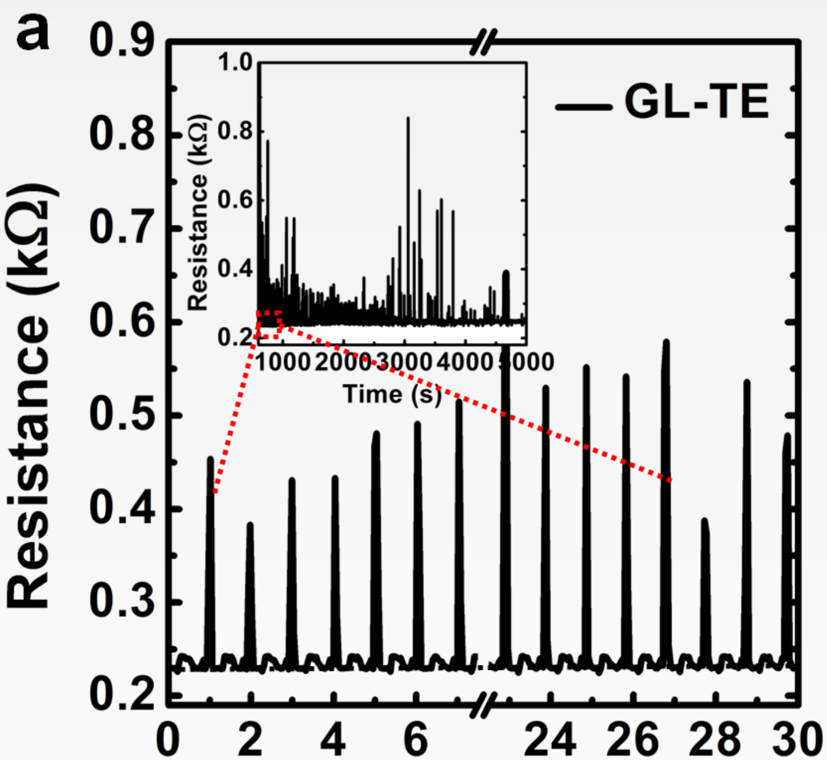
a, b) UV stability and Relative humidity test according to the resistance change while the samples were exposed to the radiation of an Xe lamp at 254 nm wavelength and humidity 80% respectively.

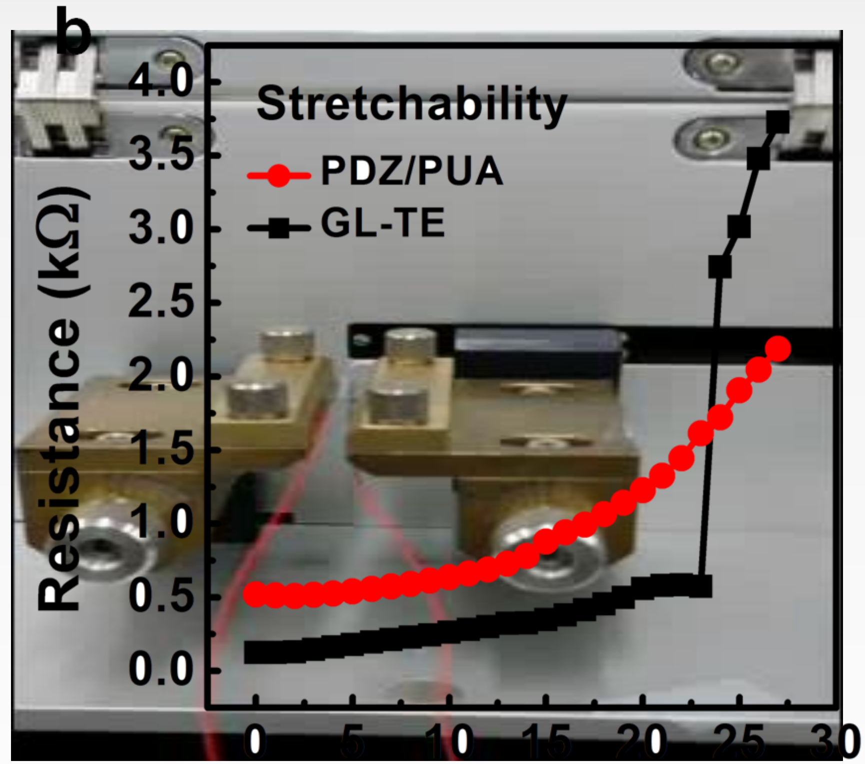
c) The change of sheet resistance of a function of the increasing temperature from 25 °C to 210 °C. GL-TE film shows the more thermal stability than PDZ film between room temperature and ~ 150 °C before PET substrate shrinkage occurs.

04. Characterization of GL-TE

Stability tests under unfavorable environmetal agents

- **Bending & Stretchability test– Enhancement of mechanical properties**





a) Responsive resistance of GL-TE film as a function of bending cycle. The response of GL-TE film was measured during bending the TE with 7.6% strain.

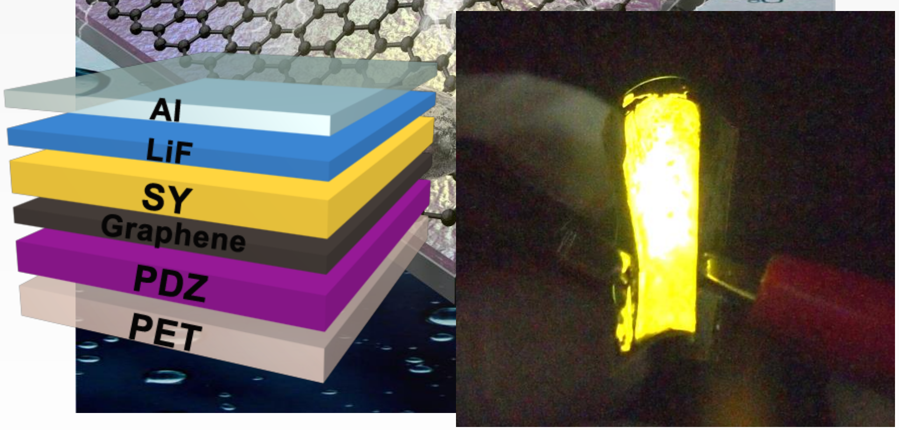
b) Comparison resistance of the PDZ/PUA (red circles) and GL-PDZ/PUA (black squares) films as a function of applied tensile strain.

05. Conclusion

Environmentally stable and highly conductive GL-TE

- Inverted PLED

- Conventional PLED



- We developed a new method for improving the lifetime and the operational and thermal stability of organic thin-film materials while maintaining high conductivity and mechanical flexibility .

- *The merits of GL-TE are as follows*

  a) Direct transfer of graphene layer

  b) Tight interfacial binding & free of wrinkles and air gaps

  c) The laminated films exhibit an outstanding room-temperature hole mobility of ≈ 85.1 $cm^2\ V^{-1}s^{-1}$

  d) Environmentally stable properties against high mechanical/thermal stress, humidity, and ultraviolet irradiation

  e) Appropriate work function energy value ~5.12 eV

  f) Considering the use of flexible organic electronics for our-door applications

Q&A

Thank you.