Piezoelectric Nanomaterial–Based Transparent Flexible power Generators: Harvesting Waste Energy

The 7th Korea–US Nano Workshop

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Nano Works in NESEL for Energy Harvesting & Saving

ZnO Nanostructures
- Nanoparticle
- Nanowires
- Nanorods
- Nanotubes

Tin-Oxide Nanostructures
- Nanobelts
- Nanowalls
- Nanodisks
- Nanotripods

- Nanogenerators
- Hybrid Solar Cells & LEDs
- Hydrogen Storage & Sensors
- Low Power-Driving Chemical Sensors

Nano Electronic Science & Engineering Laboratory (NESEL)
Mechanical Energy Sources for Nanogeneration

New Energy Scavenging from Wasted Energies!


Nano Electronic Science & Engineering Laboratory (NESEL)
Self-Powered Integrated Transparent Charge Generators

Flexible plastic top film

Transparent top electrode

ZnO nanorod array

Transparent bottom electrode

Flexible plastic substrate

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Selected as “Advances in Advance”

Nano Electronic Science & Engineering Laboratory (NESEL)
**Applications of Transparent Flexible Nanogenerators**

- **Power Consumption**

  - Fingers typing: 6.9-19 mW (M), 1.2-3.2 mW (E)

<table>
<thead>
<tr>
<th>Model</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>F700 (Samsung)</td>
<td>Resistive</td>
</tr>
<tr>
<td>iPhone (Apple)</td>
<td>Capacitive</td>
</tr>
<tr>
<td>Prada (LG)</td>
<td>Capacitive</td>
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</tbody>
</table>

**Piezoelectric Power Generation:** Self-Powered Haptic Sensor Operation

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Fabrication Scheme of Fully Rollable Transparent Nanogenerators Based on Graphene Electrodes

Graphene (made at Prof. Y. H. Lee’s Group, SKKU)

Si Ni

Transfer (Dr. J.-Y. Choi’s Group, SAIT)

Polymer

ZnO NRs growth

ZnO NRs

Integration


Polymer ZnO NRs growth Integration

Nano Electronic Science & Engineering Laboratory (NESEL)
Mode Control & Work Function Dependency (submitted)

Nano Electronic Science & Engineering Laboratory (NESEL)
Sound-Driven Piezoelectric Nanogenerators (Under review)

Nano Electronic Science & Engineering Laboratory (NESEL)
Piezoelectric Touch Sensible Flexible OPV (submitted)

Nano Electronic Science & Engineering Laboratory (NESEL)
Recent Core Collaborators: Display Lab. & Frontier Res. Lab. (SAIT), Prof. Z. L. Wang (Gatech), CIGS Solar Cell Group (ETRI), Prof. D.-H. Yoon, Prof. H.-K. Cho (SKKU), Dr. H. H. Lee, Dr. J.-H. Park (PLS), Dr. S. Lee (KIST), Prof. S.-J. Park (GIST), Prof. Sz. Fujita (Kyoto Univ.), Prof. H.-K. Kim (KUH), Prof. S. Maeng (Woosuk Univ.), Prof. W. I. Milne (Cambridge Univ.) Prof. I.-H. Lee (Chonbuk Univ.), Dr. A. Maiti (LLNL), Prof. D.-Y. Jeong (SKKU), Prof. S. Hong (SNU), Prof. C. Cho (PNU), H. Hosono (TIT) etc