Development of Mechanical Characterization Techniques and Analysis of Flexible Electronic Materials

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Overview

- Flexible PCBs are an advancement in the field of additive electronics. Flexible circuitry can be printed onto flexible plastic substrates using ink-jet printers.
- This research project aims to investigate the change in interfacial fracture strength between silver conducting ink/PET substrates due to prolonged high humidity exposure to mimic accelerated real-world use conditions of flexible electronics.

Custom 3D Printed Interfacial Wedge Tester

Results

Compared to a control group of silver ink samples that were exposed to room temperature/humidity conditions, the following changes were observed:

<table>
<thead>
<tr>
<th>Percent Change in Silver Ink Interfacial Toughness</th>
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<tbody>
<tr>
<td>24 Hour Exposure at 90% RH</td>
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<tr>
<td>5 Minute Dry</td>
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<tr>
<td>24 Hour Dry</td>
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<tr>
<td>72 Hour Dry</td>
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Conceptual Framework

Flexible electronics are frequently exposed to high humidity conditions in real-world applications. Examples include:

- Sensors mounted on flexible and complex shaped airplane airfoils
- Biomedical electronics/sensors close to/in contact with human skin
- Flexible smart devices/cell phones

- The mechanical reliability of flexible circuits used in harsh environments is sensitive to humidity.
- Data on the effect of humidity on the interfacial fracture toughness between flexible electronic material systems, such as silver conducting ink and flexible PET substrates, is necessary to build better mechanical models and to improve the mechanical reliability of flexible electronic devices.
- The silver ink/substrate interfacial fracture toughness can be measured using an Interfacial Wedge Tester.
- An environmental chamber was used to subject printed silver conducting ink on PET samples to 90% RH for 24 hours. Samples were then allowed to dry before being mechanically tested.

References

2. Enhanced Interfacial Toughness of Thermoplastic–Epoxy Interfaces Using ALD Surface Treatments
   Yuan Chen, Nicholas J. Ginga, William E. LePage, Erik Kajaks, Andrew J. Gayle, Jing Wang, Robert E. Rodriguez, M. D. Thousee, and Neil P. Desai
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