Low-Temperature Thin Film Transistors for Polymeric Piezoelectric Materials

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Polymeric Piezoelectric Materials with Low-Temperature Thin Film Transistors Polymeric piezoelectric materials possess many advantages, including relatively high sensitivity, availability in sheet form, and excellent impedance-matching to water. These properties make them attractive candidates for manufacturing active-matrix, scalable micro-devices for distributed force sensing and force generation applications, such as 2-D force imaging, directional microphones, steerable speakers, and medical devices. However, polymeric piezoelectric materials have a relatively low Curie point (90°C), above which they lose their piezoelectric properties. This presents a challenge to manufacturing locally-amplified (i.e. active) devices in amorphous silicon, because traditional manufacturing processes for silicon transistors usually require higher temperatures. This technology overcomes these difficulties using low-temperature thin film transistors such as Organic Field Effect Transistors (OFETs). By using OFETs to locally amplify signals, active polymer piezoelectric devices can be fabricated below the Curie temperature directly on flexible sheets, providing excellent acoustic coupling.

Organic Field Effect Transistors (OFETs) Provides Excellent Acoustic Coupling and Mechanical Device Flexibility When excited, a poled piezoelectric substrate film generates charge. In active-matrix piezoelectrics, changing the sensing paradigm from detecting this small charge to detecting an amplified current significantly increases the size over which detector pixels can be scaled. In this technology, an OFET, made from a conductive source and drain coupled with organic semiconductor and gate dielectric layers patterned atop the poled piezo substrate, can locally amplify charge sensed at the gate. This enables current detection or application for a piezo-coupled OFET sensor or actuator while maintaining the film’s piezoelectric properties during fabrication.

Applications:

- Distributed force-sensing applications:
  - 2D force/pressure detection
  - Detecting turbulence in gas/liquid flow (e.g. on airplane wings)
  - Artificial cochlea
- Using devices in actuator mode (i.e. for distributed “force-generation“):
  - Steerable speakers for sound projection
  - Vibration cancellation
  - Laminar flow reattachment
- Heat mapping / IR sensing (by employing pyroelectric properties)

Advantages:

- Using a locally amplified architecture makes this technology easily scalable and increases mechanical sensitivity of force-sensing devices Using devices in actuator mode (i.e. for distributed “force-generation“).
- Thin-Film Transistor-based local amplifiers can be integrated with other devices
- Low temperature (• Pyroelectric properties enable simultaneous heat mapping applications)

Licensing Status: Available for Licensing and Sponsored Research Support

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