IOWA STATE UNIVERSITY
Civil, Construction, and Environmental Engineering

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Smart Sensory Membrane for Wind Turbine Blades

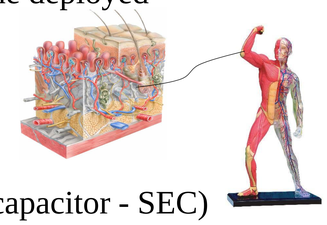
1. Problem

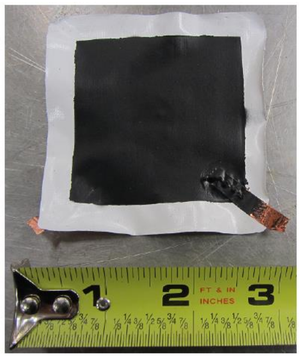
- Blades have a high rate of failure.
- Blade failures may result in:
  - Injuries
  - Turbine collapse
  - Loss of production capacity
  - High repair costs
- Regular inspections/maintenance are expensive and time consuming.
- Current sensing solutions do not allow automatic monitoring, because of technical or economical obstacles.



2. Proposed Solution

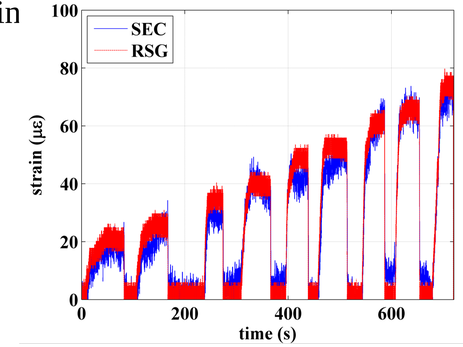
- A bio-inspired sensory membrane deployed inside the blade.
- The skin is composed of several flexible strain gauges.
- Each strain gauge is a soft piece of electronics (soft elastomeric capacitor - SEC) fabricated from an inexpensive nanocomposite.
- Strain (local elongation) is transformed into changes in the skin's electrical properties.
- The sensory membrane is:
  - Cost-effective
  - Durable
  - Easy to install
  - Low powered
  - Customizable
  - Scalable

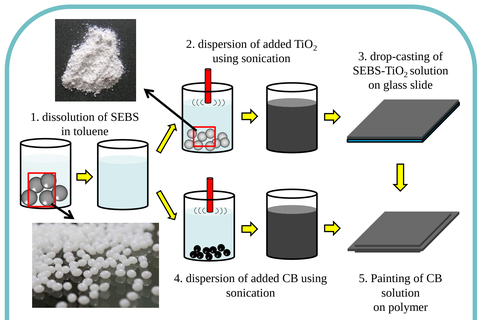




3. Technology Capabilities

- The proposed soft strain gauges (SEC) sensing cap-abilities compare well with existing sensors, such as conventional resistance-based strain gauges (RSG).



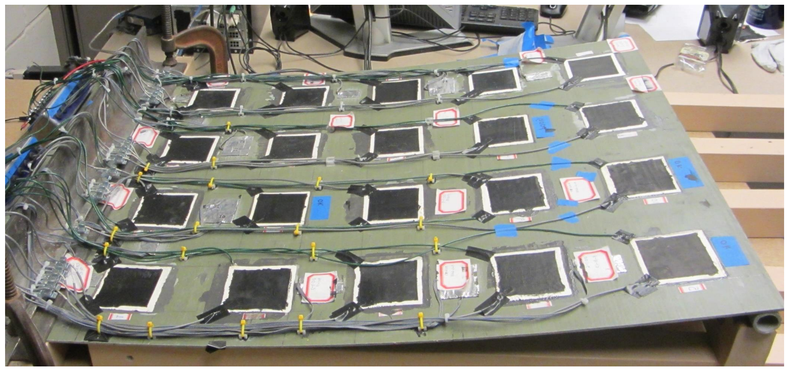


Skin fabrication process

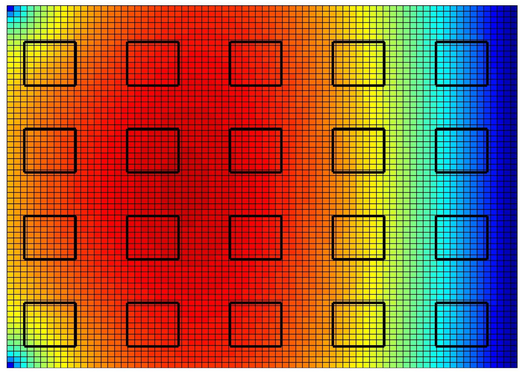
- The sensory membrane can detect:
  - Cracks
  - Surface stresses
  - Vibration signatures
  - Changes in dynamic behaviors

4. Research Results

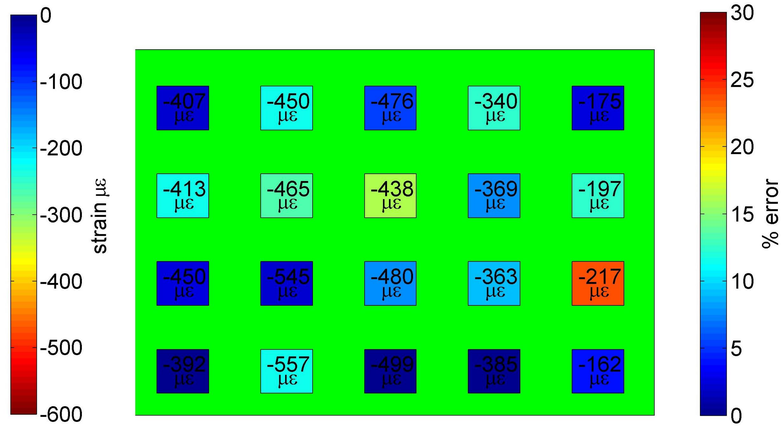
- A composite plate was fitted with 20 SECs.
- FEA was preformed and validated with resistive strain gauges (RSG).
- SEC's are compared to the FEA.



composite plate with 20 SECs, deflected 91mm



FEA results showing strain summation



SEC results showing measured strain and percent error

The development of the sensory membrane technology is supported by the Iowa Energy Center