# Development of Layered Functional Fiber-based Microtubes

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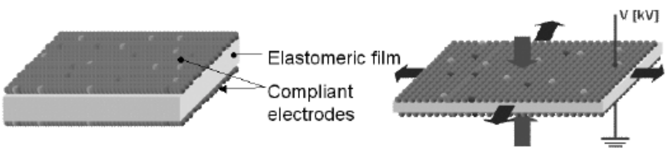
Microtubes and microtubules are very small diameter functional tubes with high aspect ratio that can be made of almost any material. Specific functions performed by microtubes may include encapsulation, heat exchange, reinforcement, detection, filtration, optical waveguide, sensing, etc. Our objective is to explore the fundamental technological potential of fabrication of microtubes from electroactive polymeric materials substantially in the form of textile fibers for applications in sensing and actuation. Our long-term objective is to develop various fiber-based functional systems at various scales (micro to large).

**We are exploring the technological potential of submicron diameter tubing of electroactive polymeric materials for applications in sensing and actuation.**

To develop the microtube actutators we intend to use dielectric polymers that show Maxwell stress. Highly dielectric polymers with low elastic modulus can induce a large actuation strain when subjected to an electrostatic field. The phenomenon is best displayed by a parallel plate capacitor with the dielectric material as the medium (See




***Dielectric polymer actuator operating principle***[1]

Figure). A pressure arises between the two electrodes of the capacitor when it is charged. This pressure, known as the Maxwell pressure, arises from the fact that opposite charges on the electrodes attract each other and the electrostatic forces resulting from the free charges squeeze and stretch the polymer.

To examine a number of microtube actuator concepts, we are exploring various layered tubular configurations of dielectric materials and conductive electrode materials. We have evaluated silicone, polyacrylate, polyurethane, and polyolefin elastomers as dielectric polymers.

To develop the required compliant electrodes we have examined graphite particles, and carbon fibers. Additionally, we used an *in situ* polymerization of polypyrrole[2] to deposit conductive polymer electrodes on opposing surfaces of polyurethane films. We will soon examine other ways of forming compliant electrodes on the dielectric materials.

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**Industry Interactions**: 2+ [Hills,Inc., Sentel Technologies]

**Project Web Address: None Reported**
http://

**For Further Information:**

1. R. Kornbluh, et al, *High-Field Electrostriction of Elastomeric Polymer Dielectrics for Actuation,* Smart Structures and Materials 1999:Electroactive Polymer Actuators and Devices, Proc. SPIE, **3669**:149 (1999).
2. J. Su, et al, *Preparation and Characterization of Electrostrictive Polyurethane Films with Conductive Polymer Electrodes* Polymers for Advanced Technologies, **9**:317 (1998).

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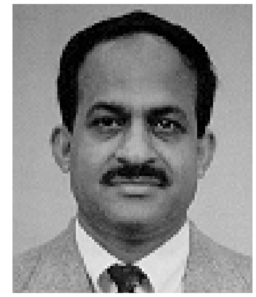

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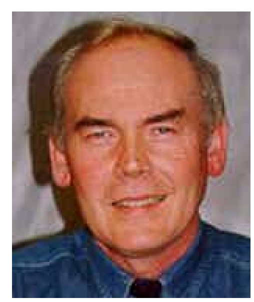

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