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ELE 482: Electroactive Polymers

Electroactive polymers are materials that change the shape or size when an electrical current is applied. Many scientists have worked to make these EAP's into artificial muscles and machines that have life-like movements to them. In the human body real muscles are bundles of fibers that contract when an electrical impulse is sent through it from the nerves. Modern machines haven't been able to replicate these movements accurately, however these electroactive polymers tend to show a fluid smooth movement that is very similar to the actual movements of the human body. The material can change its shape by applying a voltage and can return to its original shape by reversing the polarity of the applied voltage.

One study done by PolySep (Polymer and Separation Research Laboratory) used a material known as Nafion[®] to try and mimic simple muscle behaviors. They first measured the electrical and physical properties of a 0.02 cm thick electroactive polymer strips (5 cm x 0.6 cm) under dry and moist conditions. When an electrical field was applied across the EAP, the EAP deformed as a result of stresses generated by the movement of water and mobile positive ions in the polymer composite. By applying different voltages they measured the degrees of change in the shape. They found that with voltages less than one volt the changes in degrees appeared linear. They then applied different weights to the end of the Nafion and found that for every volt applied the material could lift around 1.2 grams/volt and could lift a weight of up to 70 times its own weight. One of the important characteristics was

the change that occurred over time and how fast the material could change. When the material was submerged in water the tests showed that the material would stay in place for 20-30 minutes. However when the material was exposed to the air it changed after 3 minutes, this is why it was so important that the material lie in water.

One of the leading scientist in research for EAP's is Bar-Cohen, who is actually constructing an electroactive polymer arm, has proposed an arm wrestling competition in which a robotic arm would face a human arm wrestler, this competition is set to take place next year. Presently however only two products are on the market using EAP's one of which was designed by Bar-Cohen. This product is used by NASA to wipe the lenses of cameras used in space as well as other cleaning purposes in space. The other product which is somewhat less useful is Japan's Eamex which is a battery-powered plastic fish that swims around aquariums and is practically identical to a real fish.

Perhaps the most biomedical result using the electroactive polymers is Mohsen Shahinpoor's robot designed at the University of New Mexico. He created a robot using EAP materials and bolted it to an exercise bike, the robot would pedal the exercise bike, with human like movements, as long as it was plugged into an electrical outlet. This experiment showed that an artificial hamstring or quadriceps could survive exercise in this manner. In the future these materials could be implemented into the body and react with normal nerve impulses.