California Science Center

CALIFORNIA STATE SCIENCE FAIR
2001 PROJECT SUMMARY

Your Name (List all student names if multiple authors.)
Yermie Cohen

Science Fair Use Only

J0108

Project Title (Limit: 120 characters. Those beyond 120 will be ignored. See pg. 9)
Electroactive Polymers as Artificial Muscles

Division
X **Junior (6-8)** _ **Senior (9-12)**

Preferred Category (See page 5 for descriptions.)
10 - Materials Science

Abstract (Include Objective, Methods, Results, Conclusion. See samples on page 14.)
Use no attachments. Only text inside these boxes will be used for category assignment or given to your judges.

Objective: To investigate the physical and electrical properties of an electroactive ionic metal polymer composite (IMPC), demonstrate its unique behavior and explore potential applications of electroactive polymers (EAPs) as artificial muscles.
Materials and Methods: The electrical and physical properties of a 0.02 cm thick electroactive polymer (EAP) composite strips (5 cm x 0.6 cm) were studied under dry and moist conditions. Deformation, response time and lift strength of the EAP were measured at different applied voltages and at alternate polarities. Electrical resistance was also measured to explain the effect of water evaporation on the EAP performance. Muscle-like behavior was demonstrated by a number of demonstrative experiments.
Results: The EAP can be easily deformed upon the application of low voltage (1-3.5 V). Deflection varied nearly linearly with voltage for the range of <3.5 V. Re-wetting of the EAP, after 3-5 minutes of operation, was required when operating in air. When submerged in water, however, the EAP performed continuously. The EAP was able to lift about 70 times its own weight with a force output of 20 (g lifted/g EAP)/V. The EPA response time was immediate, but final deflection was observed after about 3-15 seconds, and the rate of deformation increased with the applied voltage.
Discussion: Electroactive polymer (EAP) composites deform in response to an applied electrical potential. EAP bending toward the positive electrode is believed to occur due to migration of positive counter ions and thus water toward the negative electrode. The EAP composite deforms both in air and while immersed in water. The EAP is capable of lifting weight of up to 70 times its own weight. The EAP response time increased with increasing voltage, reaching about 7 deflection degrees/s at 3.5 V. My study suggests that the performance of the EAP could improve by creating a water impermeable coating of higher conductivity. I also predict that, over the next decade, EAP artificial muscles will have a wide range of biomedical, engineering and industrial uses.

Summary Statement (In one sentence, state what your project is about.)
My project was concerned with evaluating the future potential applications of electroactive polymers for improving our life and especially the lives of physically disabled people.

Help Received in Doing Project (e.g. Mother helped type report; Neighbor helped wire board; Used lab equipment at university X under the supervision of Dr. Y; Participant in NSF Young Scholars Program) See Display Regulation #8 on page 4.
My father helped me with the purchase of necessary materials. I also had discussions with Dr. Francesc Giralt (a family friend and a frequent visiting scientist to the University of California, Los Angeles.