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LOW MASS MUSCLE ACTUATORS (LoMMAs) USING ELECTROACTIVE POLYMERS

Y. Bar-Cohen, T. Xue, B. Joffe, S.-S. Lih, P. Willis,
JPL, Caltech, Pasadena, California, yosi@jpl.nasa.gov

J. Simpson, J. Smith, T. St. Clair,
Composites and Polymers Branch, NASA LaRC, Hampton, VA

and

M. Shahinpoor
intelligent Materials, Structures & Systems Lab, UNM, Albuquerque, NM

ABSTRACT

NASA is using actuation devices for many space applications and there is an increasing need to cut their cost as well as reduce their size, mass, and power consumption. Existing transducing actuators, such as piezoceramics, are inducing limited displacement levels. Potentially, electroactive polymers (so-called EAP) can be formed as inexpensive, low-mass, low-power, miniature muscle actuators that are superior to the widely used actuators. Under electrical excitation, EAPs contract and thus form a source for muscle actuators. Efforts were made to develop EAP materials that provide large displacements. Two EAP categories were developed that can produce actuation strain of more than 10%. These categories include: (a) ion-exchange platinum-membrane composite polymer; and (b) comb electrode polymer actuators. A comparison between EAP and the widely used transducing actuators shows that while lagging in force delivering capability, these materials are superior in mass, power consumption and displacement levels. This is producing an enabling technology of a new class of devices. Several muscle configurations were constructed to demonstrate the push and pull capabilities of EAP actuators. This technology required also the development of a new test technique of measuring the displacement and the material properties. An ultrasonic plate-wave based technique was developed to measure the thickness and the elastic constants of EAPs. The results of this study will be reported and discussed.

Key Words: Actuators, Electroactive Polymers, Active Materials

Principal Author Biography

Dr. Yoseph Bar-Cohen is a member of the Technical Staff and the NDE Principal investigator at the Materials Science and Engineering Section of the Jet Propulsion Laboratory, Pasadena, CA. Since joining JPL in 1991, he has established state-of-the-art Nondestructive Evaluation (NDE) and Active Materials Characterization Labs. Dr. Bar-Cohen received his Ph.D. in 1979 from the Hebrew University at Jerusalem in Israel. He has more than 25 years experience in NDE, sensors and electroactive materials technologies including his positions at the Israel Aircraft industry, Air Force Materials Laboratory and McDonnell Douglas Corporation. Dr. Bar-Cohen is a recognized leader in NDE and has been a pioneer in developing new experimental techniques for composite materials including the leaky Lamb waves and the polar backscattering. Currently, he is developing ultrasonic methods of measuring the elastic properties of composites, electroactive polymers for muscle actuators, space-worthy high-torque piezoelectric motors, piezoelectric pumps, ultrasonic techniques for medical applications and is involved in NASA efforts to form NASA wide Materials and Process Standards. He is the author of more than 115 publications made numerous presentation at national and international symposia and holds many patents. He also teaches courses in experimental techniques in the Department of the Mechanical Aerospace and Nuclear Engineering (MANE) at the University of California, Los Angeles (UCLA) where he holds an Adjunct Professor Position. He is widely collaborating with researchers in academic institutes as well as industry. Dr. Bar-Cohen is the Editor of the NASA NDE Working Group (NNWG) Newsletter and the Emeritus Chair of NNWG.