METHOD AND ELECTROACTIVE DEVICE FOR A DYNAMIC GRAPHICAL IMAGERY DISPLAY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a non-provisional application claiming benefit and priority under 35 U.S.C. § 119(e) from applicant's co-pending U.S. provisional application serial No. 60/663,500 filed on Mar. 18, 2005 to the instant inventor; the aforementioned provisional application is hereby incorporated by reference in its entirety as if fully set forth herein.

FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

[0002] Not Applicable

REFERENCE TO A MICROFICHE APPENDIX

[0003] Not Applicable

FIELD OF INVENTION

[0004] The present invention relates to electrically controllable graphical images. More specifically, the present invention relates to graphical images affixed to electroactive polymer materials such that they are changed in size and/or shape under electronic control.

BACKGROUND

[0005] Electroactive polymers are electronically controllable materials that convert electrical energy into mechanical displacement. Electroactive polymers are often referred to as "electric muscles" because of their similarity to muscular tissue. In addition, many of the electroactive polymers may be used as high quality sensors, particularly for time-varying (i.e. alternating current) signals. When mechanically deformed (e.g. by bending, pulling, etc.), many electroactive polymers develop differential voltages which can be electrically measured.

[0006] A unique property of these materials is their low current requirements in relation to the degree of conformational change exhibited. Electroactive polymers are a class of polymers which may be formulated and/or processed to exhibit a wide range of physical, electrical, and electro-optical behaviors and properties. When energized with a sufficient electromotive force, electroactive polymers undergo significant physical movement or deformations, typically referred to as electrostriction.

[0007] Electrostriction is a property of electrical non-conductors (dielectrics) that produces a conformational change, or mechanical deformation, under the application of an electric field. Reversal of the electromotive force does not reverse the direction of the deformation. The selection of the dielectrics used in the production of the electroactive polymers determines the magnitude of the deformation.

[0008] The deformations may occur along a length, width, thickness, radius, etc. of the electroactive polymer and in some cases can exceed 100% strain. Elastic strains of this magnitude are uncommon in typical dielectric materials and are even more unusual in that the degree of deformation may be fully controlled with the proper electronic systems. Materials in this class can be used to do useful work in a compact, easy to control, low power, fast, and potentially inexpensive package.

[0009] A variety of electroactive polymers structures are described in the technical papers, "High-Field Electrostriction of Elastomeric Polymer Dielectrics for Actuator," by Kombluh et al., "Electro-Mechanics of lonoelastic Beams as Electrically-Controllable Artificial Muscles," by M. Shahinpoor, "Polymer Electrolyte Actuator with Gold Electrodes," by K. Oguro et al., and "Microgripper Design Using Electro-Active Polymers," by R. Lumia et al. All of the above cited references were obtained from the "SPIE Conference on Electroactive Polymer Actuators and Devices," SPIE Vol. 3669, 1999, and are hereby incorporated by reference.

[0010] Electrostrictive type electroactive polymers are typically constructed from two electrically conductive and compliant electrodes with a dielectric polymer sandwiched between the two electrodes. When significant electromotive forces are exerted on the electrodes, the attractive force of the electrodes constricts the intervening dielectric such that significant motion (strain) is induced. An advantage of the electrostrictive type of electroactive polymers is that deformation may occur uniformly or non-uniformly, across the entire material or at select portions of the material, depending upon the magnitude of electromotive force applied and/or the placement of the electrodes comprising the electroactive graphical imagery display device.

[0011] In general, commercial implementations of electroactive polymers have been directed toward development of actuators (e.g., motors) for powering movable robots and mechanical equipment. For example, U.S. Pat. No. 6,376,971, entitled "Electroactive Polymer Electrode," to Pelrine et al., and issued on Apr. 23, 2002, provide methods for pre-straining electroactive polymers to improve the conversion of electrical energy to mechanical energy. In addition, the patent to Pelrine et al., provides various form factors useful for implementing electrostrictive type electroactive polymers and is herein incorporated by reference in its entirety.

[0012] U.S. patent pending application Ser. No. 09/866,385 to Schena, entitled, "Haptic Devices Using Electroactive Polymers," and filed on May 24, 2001, discloses a wide variety of devices using electroactive polymer actuators. This pending application to Schena is likewise herein incorporated by reference in its entity. However, none of the above cited references provides implementations of electroactive polymers for enabling visually dynamic graphical imagery for applications such as advertising, children's books, apparel, pushbuttons, curios, ornaments or logos which are believed useful and desirous in the relevant art.

SUMMARY

[0013] The invention as described herein addresses the need in the relevant art and provides in various inventive embodiments a graphical imagery display device and method of providing the graphical imagery display device. In a first device embodiment of the invention, a electroactive graphical imagery display device comprises an electroactive polymer device; the electroactive polymer device including a plurality of electrodes and at least one exposed surface. An electromotive force generator is operatively coupled to the plurality of electrodes and a graphical image is affixed to at