Modelling of high output force dielectric elastomer actuator

ABSTRACT

Restoring the function of a lost limb for an amputee requires the generation of relatively large forces, which remains a challenge in current designs. Dielectric Elastomers (DE) have the desired properties of light weight, low cost, fast response, ease of control and low power consumption. Yet due to the elasticity of the material which requires mechanical support and low output force generation, DEs haven't been suggested for prosthetic devices that mainly require high output forces. This paper proposes a conceptual design for a prosthetic arm, where DE is used as a high output force actuator. A two-bar mechanism was assumed to represent the human arm, with one bar as the Humerus and another for the Radius and the Ulna bones. The flexion action of the mechanism was achieved by a slider-crank mechanism connecting the two bars. A Dielectric Elastomer (DE) was used to actuate the mechanism. In the proposed design, the DE membrane is configured as a planar linear actuator, with about 1000 parallel membranes to maintain the output force and reduce the tensile stress. An Analytic model for the specific configuration of DE materials was developed to analyze the output force of the designed mechanism for a range of input electric fields. The input electric field is below the dielectric strength of the material and induces 97 N of output force which is higher than reported actuator designs.

Keyword: Dielectric elastomer; Actuator; Thermodynamics; VHB 4910