Soft Linear Actuator Based on Dielectric Elastomer

H. R. Choi¹, Min Young Jung¹, Nguyen Huu Chuc¹, Jung Woo Kim¹, Ig Mo Koo¹, Kwang Mok Jung¹, Y. K. Lee², J. D. Nam², J. C. Koo¹, a

¹School of mechanical engineering
²School of applied chemistry and chemical engineering
Sungkyunkwan University, Suwon, Korea 440-746
aCorresponding Author : jckoo@skku.edu

Keywords: Electroactive Polymer(EAP), Artificial muscle actuator, Cylindrical actuator, Dielectric elastomer, Tube-Spring Actuator(TSA).

Abstract. This paper presents a new design of an artificial muscle actuator called tube-spring actuator (TSA) that is fabricated with dielectric elastomer. The new actuator construction includes two steps: the first is that a cylindrical actuator is manufactured with dielectric elastomer with multi-layer lamination process. Then a compressed spring is inserted to inside the tube as the second step of the process. The inner spring is used to maximize the axial deformation while constraining the radial contraction. This design enables effective linear actuation with largest amount strain. The monitored strain of active length is up to 15 percents. The manufactured actuator is applied to a robot hand as an example of the actual application.

Introduction

For many years, electroactive polymers (EAP) are popularly studied as substitutes of the traditional electromagnetic actuators for their compliant, versatile, low density, and low cost characteristics as necessity of the new actuators for various small scale applications grows. Dielectric elastomer is one of the particular class of EAPs and has been proven to be able to generate strains greater than those obtainable from other types of EAP. They are forecasted today as suitable materials to realize high performance devices for the actuation where small physical space is available so that no types of electromagnetic transducers could be used. As reported in the previous researches, the performance of the dielectric elastomer largely depends on the electrical properties, especially dielectric constant and breakdown voltage as well as dominated by the mechanical properties such as elastic modulus, stress relaxation, and viscous damping. There are numerous dielectric elastomers commercially available such as silicone, polyurethane, acrylic elastomer etc.[1-2] In this paper we propose a new linear actuator, called tube-spring actuator (TSA) by adopting the advantage of the tube actuator. TSA is a cylindrical multi-layered dielectric elastomer actuator that is reinforced by a cylindrical inner spring. The compressed spring enhances the axial elongation whereas constrains the radial contraction.

Tube-Spring Actuator (TSA)

Recognizing the advantage of combination of the cylindrical actuator and the compressed spring for a robotic application, there are some problems to be cleared for the successful application to a robot part. The dielectric elastomer actuators should basically contain two regions active and non-active regions, as described in Fig. 1. The active region refers to the area covered with the electrode and under the influence of electric field. The non-active region corresponds to the bare elastomer substrate without covering of electrode. The existence of the non-active area is a serious drawback of the actuators because it obstructs the deformation of active region.