Development of a Soft Linear Motion Actuator using Synthetic Rubber

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Abstract. As ElectroActive Polymers (EAPs) attract keen attentions from various engineering fields, they have been proven more beneficial over the traditional electromagnetic transducers. In the present paper, a new polymeric material that could be adopted for a dielectric elastomer actuator is introduced. The proposed synthetic rubber produces larger deformation at higher energy efficiency compared to previously known dielectric elastomers. A method for the material synthesis and a set of comparative testing of the material to the existing material are to be mentioned in the present work. In addition, benefits of actuators made with the proposed material are discussed.

Introduction

For many years, electroactive polymer (EAP) has been adopted by many researchers for a new efficient energy transformers. Dielectric elastomer which is one of the most popular EAPs has been proven to be able to generate larger strains and faster response compare to other EAPs. Actuators made with EAPs are expected to substitute traditional electromagnetic transducers in many industrial applications. As reported in previous publications, the performance of the dielectric elastomer largely depends on its electrical properties, especially dielectric constant, breakdown voltage as well as the mechanical property, such as elastic modulus, stress relaxation and viscous damping. There are numerous dielectric elastomers commercially available such as silicone, polyurethane, acrylic elastomer (3M) etc.[1-5]. However, they have several drawbacks and the improvement of the material properties are strongly demanded to be used as an actuator in practical applications. In this work, we introduce a synthetic rubber developed by ourselves, which can be used as a new dielectric material for the actuator.

Focusing on the dielectric constant as a major factor of the actuation, a new synthetic rubber is developed to have high dielectric constant. Also, improvements of the principal mechanical properties are gained, which are concerned with the measure of reliability in the actuator. Its performances are experimentally evaluated and its advantages are addressed by comparing with the existing ones. A numerical model is also formulated and simulation results are shown for the verification of the proposed concept.

Synthetic Rubber as New Material for Dielectric Elastomer

In this work we have developed a material, a kind of synthetic rubber, which has quite stable mechanical behavior and large dielectric constant. Since the vulcanization in the manufacturing process of the rubber forms a cross-link between sulfur and rubber molecule chains, the material can have less viscosity and better elastic property than the others. In fact, the natural rubber has almost the same dielectric constant as that of the silicone elastomer the most popular currently. To increase dielectric constant of the rubber, we have synthesized the material with specially developed recipe, which has 8 times higher dielectric constant ($\varepsilon_r = 25$) than normal one ($\varepsilon_r = 3$).