Proc. of the 2nd International Conference on Electrical, Communication and Computer Engineering (ICECCE)
14-15 April 2020, Istanbul, Turkey

The Temperature Effect on the Characteristics of the Dielectric Elastomer Actuator

Alaa Al-Ibadi
Computer Engineering Department
University of Basrah
Basrah, Iraq
orcid.org/0000-0002-0779-8217

Mohammed Al- Atwani
Computer Engineering Department
University of Basrah
Basrah, Iraq
mohammed.kade@uobasrah.edu.iq

***Abstract*— In this paper, the material constant of the dielectric elastomer (DE) has been observed under three parameters; the electrical frequency, the prestretch ratio, and the environmental temperature. While the dielectric elastomer actuator (DEA) can be used under different environmental conditions, the temperature factor is considered in this paper at the prestretch condition and various frequencies. Which shows a significant effect on the constant of the DEA.**

Keywords*— *Dielectric Elastomer (DE), Soft Actuators, Temperature, Material Constant, Prestretch Ratio.

I. Introduction

The high demands of using robots in medical applications such as rehabilitation and surgery increase the requirement to invent more friendly types of robot systems. In comparison with traditional rigid robots, the soft robots which are made from soft and flexible materials provide numerous advantages such as small weight to force ratio, compliance, environment friendly, safe to human-robot cooperative, low cost, and flexibility to deform and manufacturing [1-3]. Several types of actuators which are made from smart materials such as shape memory alloy (SMA) which offer actuate by changing its temperature [4], and the pneumatic muscle actuator (PMA). The PMA has numerous shapes and actuation behaviours including liner contraction and expansion [5] [6], bending, and circular pneumatic muscle actuator (CPMA) [7]. One of the major types of soft actuators that attract the researchers during the last decade is the dielectric elastomer actuator (DEA) [8] [9]. Utilizing the dielectric elastomer (DE) has been increasing dramatically to design soft actuators for use in robotic design due to its ability to deform and actuate under several factors such as the applied voltage and material dimensions [1] [10].

The DEA has been developed and its model is discussed by many researchers. The twisting DEA has been proposed by [11]. Rolled actuators are developed by [12] and [13]. The hemispherical shape has been presented in [14].

Modelling of the DEA is presented by [15] [16] and [17]. The effect of the frequency on the DE material constant has been observed by [8] under various prestretch ratios.

Because of the wide use of the DEA and to test how the environment may affect the material characteristics, this paper presents the effect of the environment temperature on the DE constant at various frequencies.

The definition of the DE and the actuation principle are given in section two. Section three presents the experiment and its results. And the paper outcomes are concluded in section four.

II. Dielectric Elastomer

The dielectric elastomer actuator is usually made from soft elastomeric membranes as a sandwich with two electrodes. The electrodes need to be compliant due to the softness and the flexibility of the DEA. Carbon black, thin copper tab and numerous carbon-based materials are commonly used for electrodes.

The DEA one of the soft electroactive materials affected by the electrical voltages. The applied voltage deforms the shape of the DE and provides actuation. Fig.1 shows the construction of the DEA.

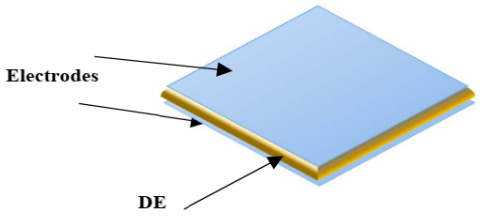

Fig. 1. The construction of the dielectric elastomer actuator

The actuation behaviour of the DEA depends on its dimensions and, the position and shape of electrodes. The main aim of this paper is to study the effect of the environment temperature on the characteristics of the DEA.

III. Experiments and Results

The principle operation of the DE can be expressed by (1) as follows:

$$P = \varepsilon_0 \varepsilon_r E^2 \quad (1)$$

P represents the electrostatic pressure, ε_0 and ε_r are the vacuum permittivity (8.854 X 10^{-12} F/m) and the dielectric material constant respectively. E is the electric field.

978-1-7281-7116-6/20/$31.00 ©2020 IEEE