（Form6）

論　文　要　旨
Thesis Abstract

(yyyy/mm/dd)　2022 年　08 月　21 日

※報告番号	甲第３２０号	氏　名 (Name)	Ardi Wiranata

主論文題名　（Title）

Simple and Reliable Fabrication Process of Dielectric Elastomer Sensors and Actuators for Soft Robotics

内容の要旨　（Abstract）

Soft robots have received much attention from researchers due to their flexibility. A critical point in their development is the advanced technologies of soft actuators and sensors. There are many examples of soft actuators, including soft pneumatic actuators, gel actuators, stretchable pumps, and dielectric elastomer actuators (DEAs). Of these, DEAs are promising technology for soft actuators because they have a high energy density and fast response.

DEAs consist of a thin elastomer membrane sandwiched between two stretchable electrodes. The electrostatic force upon applying a voltage to the stretchable electrodes squeezes the elastomer membrane in the thickness direction, causing the DEA to expand in the planar directions. To optimize the actuation performance of DEAs, the stretchable electrode must preserve the electrical conductivity while sustaining large deformations and a high durability over thousands of cycles without adding additional stiffness to elastomer membranes. Recently, researchers have reported novel technologies to fabricate stretchable electrodes such as electrode pad printing, Langmuir-Schaefer (LS), and supersonic cluster beam implantation (SCBI). These fabrication methods require complex steps and special equipment to produce stretchable electrodes. Currently, rapid, easy, reliable, and cost-effective methods to fabricate stretchable electrodes remain challenging.

This work presents a simple and reliable fabrication process of stretchable electrodes for dielectric elastomer (DE) sensors and actuators with applications in soft robotics and wearable devices. The initial fabrication process of powdered-based DEAs involved a manual brushing method. Then the compatibility of the brushing method with the elastomer was improved by optimizing the elastomer quality. The next research stage was to automate the brushing process. The aim of this automation was to remove the human influence in the brushing process. The last step was to apply stretchable electrodes in both DEAs and wearable devices.

To assess the quality of the electromechanical properties of the stretchable electrodes, a customized electromechanical tensile test device was developed. The final test device integrated three standalone devices. Python software was used to integrate the three devices and provide a graphic user interface (GUI) for easy operation. This customized electromechanical tensile test should facilitate advances in soft robotics, especially soft and stretchable sensors. Furthermore, this electromechanical setup should contribute to the development of laboratory facilities and the educational field, especially the understanding of the electromechanical properties of stretchable conductive materials.

Additionally, reducing the driving voltage of DEAs provides an opportunity to use DEAs as wearable devices. A suitable strategy to achieve low voltage DEAs is to reduce the elastomeric membrane thickness to the nanometer range. This additional research aims to reduce the driving voltage by fabricating a nanometer-sized elastomer. This was achieved by integrating the previously reported roll-to-roll method to fabricate stretchable electrodes and the elastomer membrane. This research should contribute to the development of soft robotics, especially stretchable sensors and actuators (DEAs and DEs).

※official use only

（Form6）

論　　文　　要　　旨
Thesis Abstract

(yyyy/mm/dd)　　　　年　　月　　日

※ 報告番号	第　　　　号	氏　名 (Name)	

内容の要旨(Abstract)

※official use only