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Textile Tactile Sensor based on Ferroelectret for Gesture Recognition

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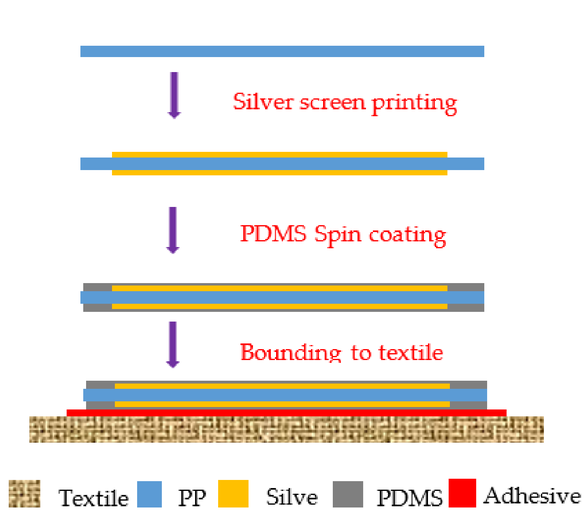
1 Introduction

Ferroelectrets are thin films of polymer foams which can store electric charges in its internal voids, exhibiting strong piezoelectric properties after electric charging. The typical internal structure of ferroelectret foam is randomly arranged cellular voids with positive and negative charges stored separately on each surface of the void. Due to the internal structure, the elastic modulus of the ferroelectret is low. The ferroelectret will undergo large deformation when a compressed, presenting a strong piezoelectric effect. The conventional piezoelectric materials, such as lead zirconate titanate (PZT) and polyvinylidene fluoride (PVDF), are not suitable for wearable kinetic energy harvesting application due to physically hardness and brittleness of PZT and low piezoelectric properties of PVDF. This poster report the first realization of a wearable textile substrate tactile sensor based on Polypropylene (PP) ferroelectret material for gesture recognition.

2 Experiential procedure

The fabrication processes of a wearable tactile sensor based on PP ferroelectret film for gesture recognition is illustrated in Figure 1.



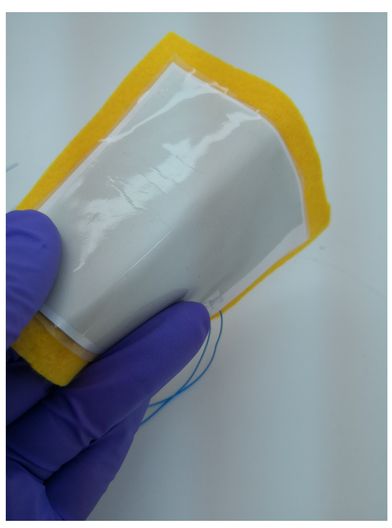


Figure 1. The schematic of fabrication processes for the ferroelectret tactile sensor and the photo of fabricated tactile sensor

Fabrication processes

- A thin layer of silver electrodes was screen printed on the top and bottom of the PP ferroelectret
- Use a small piece of conductive tape to stick the external wire to the electrodes
- After these electrodes were cured, a thin layer of PDMS was casted on these electrodes by spin coating as an encapsulate layer
- The PDMS encapsulate layer was left at room temperature in air to cure
- Then, the fabricated ferroelectret tactile sensor was bounded to a textile substrate (glove) by a thin layer of adhesive tape, as shown in Figure 2

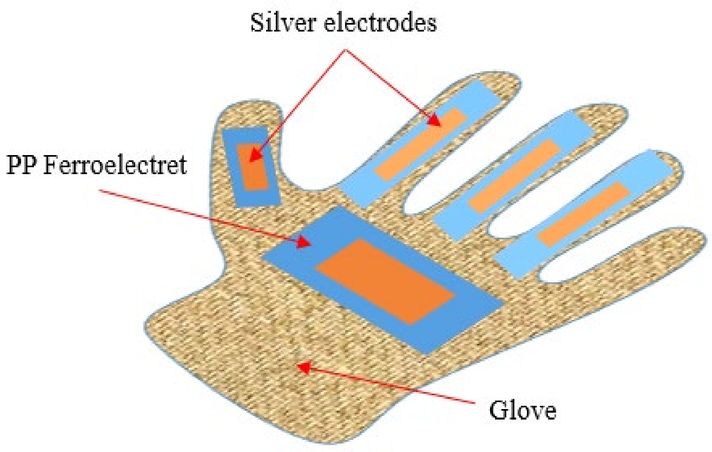


Figure 2. The schematic of diagram of the ferroelectret tactile sensor system for gesture recognition

3 Results:

To explain the sensing mechanism for gesture recognition, the output voltage curve of the ferroelectret sensor during the entire process from bending to relaxing of the finger is shown in Figure 4. Compared with the process of releasing, the maximum voltage amplitude increases to 0.8 V during the finger bending. Afterwards, the voltage returns to its original value when no further pressure is applied. A maximum voltage amplitude 0.6 V was measured while releasing. To quantify the sensitivity of the fabricated tactile sensor, the sensor was tested under an external pressure is applied by an electrodynamic instrument (ElectroPuls E1000, Instron Ltd). The open circuit peak voltage as a function of external pressure is demonstrated in Figure 5. There is a direct linear relationship between the measured open voltage and the external pressure. The sensitivity of the tactile sensor is 0.21 V/kPa in the pressure range of 0-20 kPa.

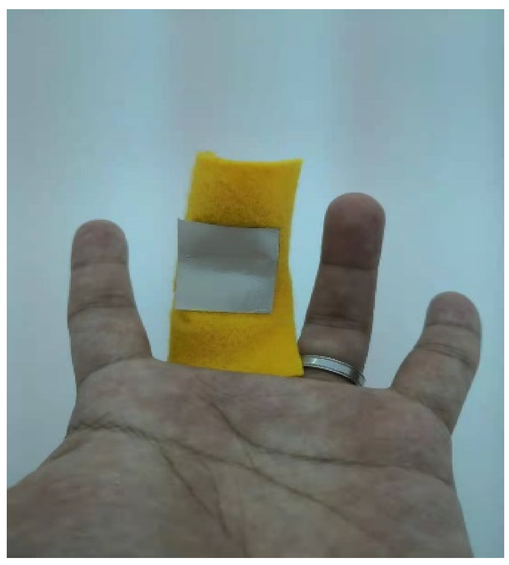


Figure 3. The image of ferroelectret tactile sensor for finger bending

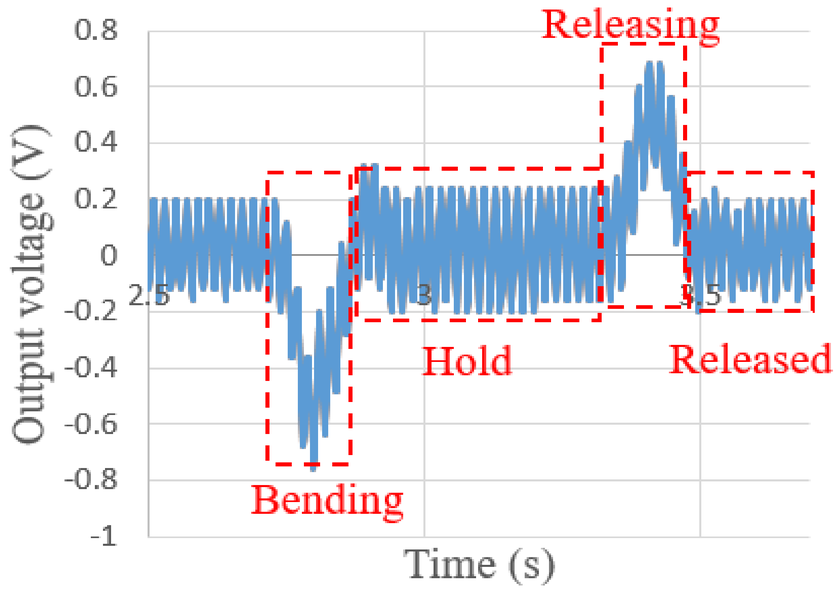


Figure 4. Output voltage of the ferroelectret tactile sensor under different states for a finger bending.

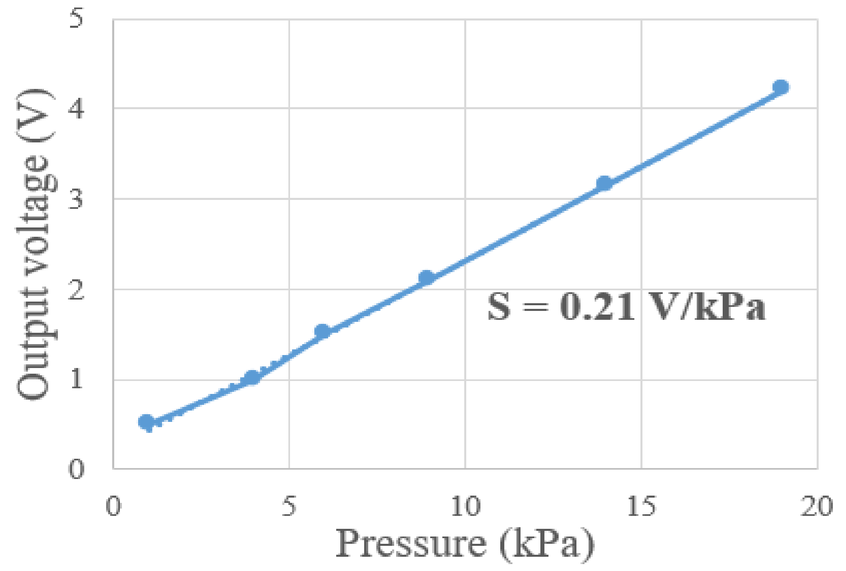


Figure 5. Output voltage response under different pressure. The sensitivity of the ferroelectret sensor is 0.21 V/kPa in the pressure range of 0-20 kPa.

4 Conclusions:

In this work, we present the first realization of a wearable textile substrate tactile sensor based on Polypropylene (PP) ferroelectret material for gesture recognition. PP is a typical ferroelectret with cellular void structures that generate giant dipole moments across the material's thickness. Upon applying pressure or bending, the change in the dipole moments generates a change in the accumulated electric charge on each surface of the PP film. The sensitivity of the fabricated sensor is 0.21 V/kPa in the pressure range of 0-20 kPa, The ferroelectret tactile sensor is adhered to a glove's surface for detecting human movements such as bending/relaxation motion of the palm, bending/stretching motion of each finger, enabling successful detection of small finger gestures with around 400 mV output.

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