THERMAL SENSITIVITY OF PEDOT:PSS FILM COATED ON TEXTILE FABRIC: A PRELIMINARY REPORT ON ITS POTENTIAL APPLICATION FOR SMART TEXTILE-BASED THERMAL SENSOR

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EXTENDED ABSTRACT

Key Words: PEDOT:PSS; THERMAL SENSITIVITY; TEXTILE SENSOR: CONDUCTIVE COATING.

1. INTRODUCTION

PEDOT:PSS is one of several widely used conductive polymers with exceptional electrical and optical properties, showing metal-like or semiconductor characteristics [1]. It has been developed in various applications, including those for making smart textile-based thermal sensors [2-6]. In principle, the microstructure of the polymer material forming the so-called core-shell structured grains makes the PEDOT:PSS possess temperature dependent properties [7], which can be utilized for some kind of temperature sensor or thermoelectric generator. Its stretchable behavior allows integration into the flexible textile structure, which can be achieved by several methods of fabrication such as inkjet printing [4] and coating methods. In this report, we present the results from a preliminary study on developing a smart flexible textile-based thermal sensor using a commercial PEDOT:PSS based on our coating technique [8].

2. MATERIAL AND METHOD

A layer of 5 × 5 cm^2 of woven twill polyester-cotton fabric having a warp and weft density 42 yarns/cm and 29 yarns/cm respectively was used as medium for the coating. To avoid over diffusion during the coating process of the PEDOT:PSS dispersion, the fabric was pre-treated by a hydrocarbon based water repellent agent to make a hydrophobic surface, see **Fig. 1**(a). The fabric was then masked by a layer of thermoplastic polyurethane (TPU) on the its surface, except for the area where the coating will be applied (6mm × 10 mm) in the middle of the fabric as shown in **Fig. 1**(b).

Two threads of electroconductive stainless-steel yarns (Bekaert Bekinox) were stitched in the area where the PEDOT:PSS will be coated, as a conductive wire to connect it with the measuring device. The M121 PEDOT:PSS A1 4083 (Ossila) was then drop-coated on the provided coating area. To form a thick layer of PEDOT:PSS film, seven drops of the 1.5% dispersion of PEDOT:PSS was done followed by drying at 90-100 ^{o}C for 10 minutes in between each drop. Based on our measurement using two points probe method, the PEDOT:PSS used for this study had a high resistivity, i.e. 1000 Ω.cm. **Fig. 1**(b) shows the final appearance of the device. Two identical devices were prepared for every measurement.

To test the thermal sensitivity of the coating, charge-discharge profiles of each device were measured using an Arduino Uno microcontroller at various temperature, i.e. 30, 32, 34, and 40 °C. The charging process was performed 5 V for 1000s, which was then followed by a discharging process for another 1000s. To check the stability of the charge-discharge profile, the charge-discharge process was carried out three-time during the continuous measurement. The device was stored for one week between measurements at different temperature to make sure that the polymer arrangement returned to their initial state.

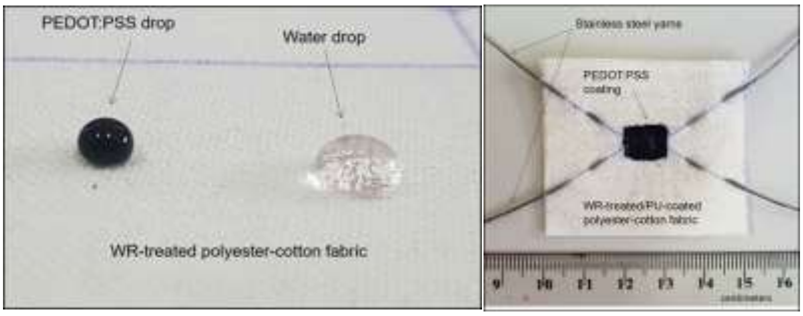

Figure 1. (a) Drop test of WR-treated fabric; (b) Example of the coating on the fabric

3. EXPERIMENTAL RESULTS AND DISCUSSION

Figure 2 presents the charge-discharge profiles of the coating measured with the microcontroller Arduino Uno in a three-time continuous measurement. One week was given to between measurement at different temperature to make sure that the polymer arrangement has been back to their initial state.

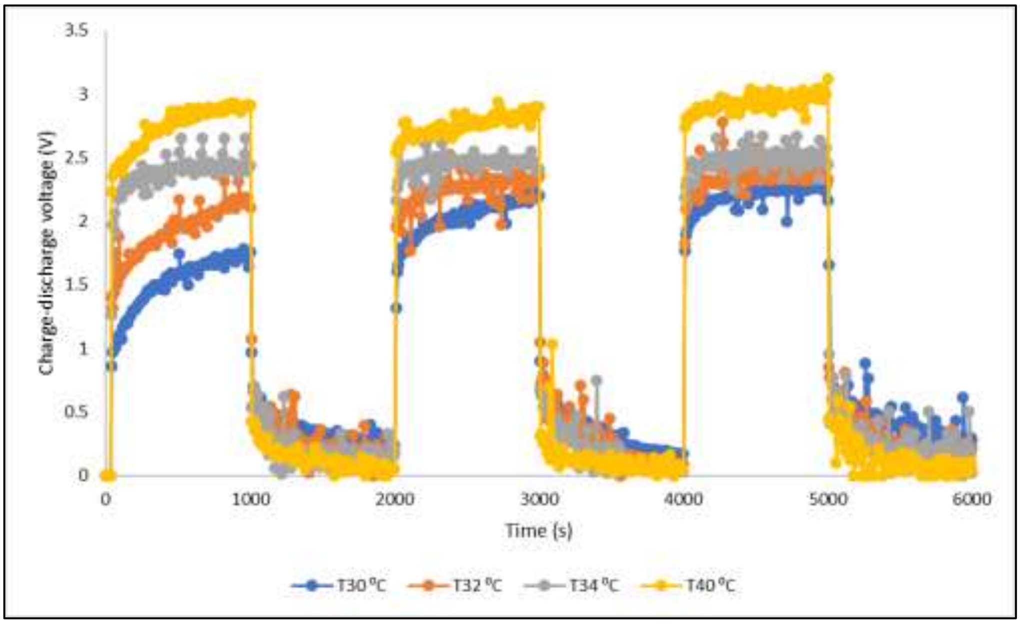

Figure 2. Charge-discharge profiles of the PEDOT:PSS-coated fabric at various T

It can be seen from the graphs in **Fig. 2** that the PEDOT:PSS-coated film on the textile fabric had a good thermal sensitivity with a good rerodicibility of the results. Measurements to the two identical sample gave identical results. The presented data is the average taken from the two measurements. The charge-discharge profiles in the graphs showed consistent increase of the charging voltage during the charging process as the temperature increased from 30 to 34 ºC. The charging voltage increased about 0.3-0.4 volt in average when the temperature was 2 ºC increased. However, the increase was not proportional when the temperature was raised up to 40 ºC.

Vice versa, the discharge voltage decreased as the temperature increased. Previous tests at low (5 ºC), room (26-27 ºC), and high temperature (40 ºC) also showed this behavior with the discharge voltage at low temperature higher than that at room temperature, while at high temperature the discharge voltage showed instability at the lower voltages, which in the presented results is absent, presumably due to an improved coating technique. The change of the core-shell arrangement of the PEDOT:PSS in relation with the presence of water at a particular temperature could also play an important role, but further studies are required.

4. CONCLUSION

This preliminary measurement showed that the type of PEDOT:PSS under study was promising for its application as a flexible thermal sensor in the form of thick coating on a layer of textile fabric. The coating method can be used in further studies, with more analysis required to fully utilize this principle as a temperature sensor.

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