Characterization of Mixed Conducting Materials in Bioelectronics

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I. Abstract

For the last twenty years, the research in organic electronics devices has increased tremendously, and with this, the field of thin-film transistors has been involved.[1] Current transistors are made mostly of inorganic materials, such as silicon. However, organic electrochemical transistors are very promising in biomedical and healthcare research for bioelectronics devices. These devices are based on semiconducting polymers. These semiconducting polymers are mostly known because they are flexibles and can be found in bendable devices, allowing us to work with solution-based fabrication at a low cost. The OECT's devices consist of a gate, a source, and a drain, where occurs a transfer of ions between the channels. Here we discuss the behavior of poly(3,4-ethylene dioxythiophene), poly(styrene sulfonate) (PEDOT:PSS), and other mixed conductors as 3,4-Propylenedioxythiophene (ProDOT) in these devices.

II. Introduction

Organic electrochemical transistors are promising devices in biomedical and healthcare research. The focus of this research was the fabrication of OECT's based on organic mixed conductors such as poly(3,4-ethylene dioxythiophene) poly(styrene sulfonate), PEDOT:PSS, and other mixed organic conductors as 3,4-Propylenedioxythiophene (ProDOT). This research also involved measuring the device characteristics of various OECTs and the connection of the electrochemistry of different mixed conductors to their performance as OECT materials. OECT's are thin-film transistors with a gate and channel based on a source and a drain. These devices allow the ions to pass through the channel and change the conductivity by electrochemical doping. This project consisted of investigating the behavior of two semiconductor polymers in OECT devices. This type of semiconducting polymers are flexibles, and you can find them in bendable devices. As mentioned above, PEDOT:PSS and ProDOT were the organic mixed conductors used. However, the differences between these polymers are based on the conductivity of each one. PEDOT:PSS is a complex composite conductor; this polymer contains two polymers and a microstructure. It has a poor understanding of the material properties, but it works well in aqueous environments.

III. Experimental Method

The organic electrochemical transistors were treated in H2O, Acetone, and IPA for ten minutes each in an Ultrasonic Sonicating Machine. After sonicating the devices, we dry each one with nitrogen, then transfer them to be treated with UV-Ozone for ten more minutes. Each one of the substrates was saved on a Petri Dish to prepare the solutions. After finishing cleaning each of the substrates, each was used in the spin coating machine. With the polymer poly(3,4-ethylene dioxythiophene) poly(styrene sulfonate), a syringe and filter put the solution in the substrate. Some parameters were set to each of them and then put on a heating plate. After letting them dry properly, a microscope was used to see if the coating was coated adequately on the substrate. Finally, we used a counter electrode, a working electrode, and a reference electrode for each one of the tests.

IV. Results

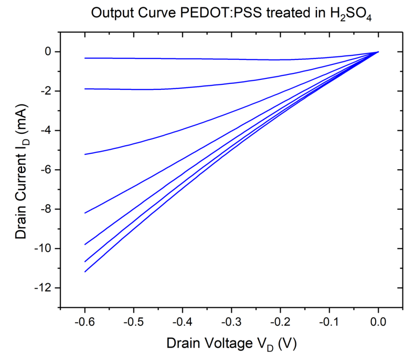

Figure 1. Shows the measurements of the output curve while the program was conducting the cycling.

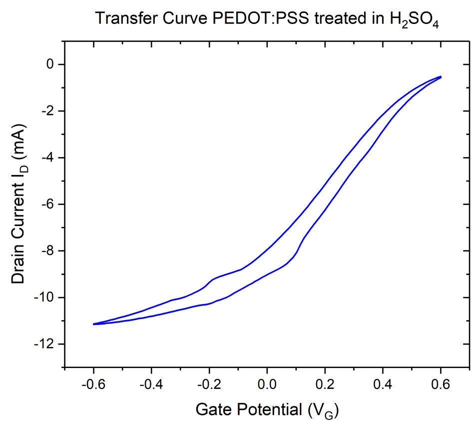

Figure 2. Shows the transfer curve measurements while the program was conducting the cycling, acting as a switch.

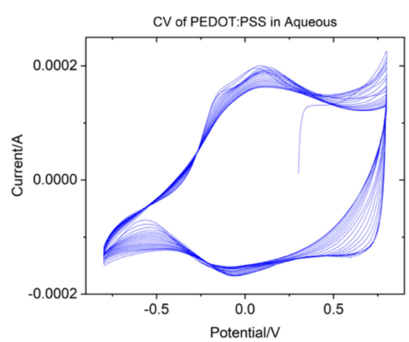

Figure 3. Cyclic Voltammetry of a sample made of PEDOT:PSS dissolved in aqueous.

The output curves allow us to understand the changes in different values between the Drain Current vs. Drain Voltage. Figure 1 shows the behavior of the output curve of poly(3,4-ethylene dioxythiophene) poly(styrene sulfonate)(PEDOT:PSS) treated in Sulfuric Acid (H_2SO_4). We obtain a sequence of values from +600mV to -600mV.

V. Conclusions

The device characteristics of the organic electrochemical transistors coated with poly(3,4-ethylene dioxythiophene) poly(styrene sulfonate) (PEDOT:PSS) allow us to see the behavior of this polymer while the cycling was running. While the program was running, we saw the reaction and the changes that occur while it was changing from ion-conducting to mixed-conducting. In the case of the poly(3,4-ethylene dioxythiophene) poly(styrene sulfonate), we observed how it went from blue to transparent, while with 3,4-Propylenedioxythiophene (ProDOT), we saw the changes from magenta to clear. This running in the Cyclic Voltammetry helped us understand and watch how it changed between both states and obtained good data from that run.

VI. Acknowledgments

This work is supported by the National Science Foundation Research Experiences for undergraduates (REU) site under grant NSF EEC 1757579. I want to thank Dr. Natalie Stingelin, my mentors Marlow Durbin and Seong-Min Kim, and all the members of the Stingelin Lab for all their help and support throughout this experience. I also like to thank Leslie O'Neill, Dr. Quinn Spadola, NSF, and NNCI for this incredible opportunity. Also, I want to thank Dr. Manuel Jiménez Cedeño and Dr. Carla López del Puerto for their mentorship and guidance for this opportunity.

VII. References

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