### University of Arizona

# Materials Science and Engineering

## MSE 110: Solid State Chemistry

##### Preparation and characterization of a conductive polymer

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**Introduction**

The purpose of the experiment was to determine the conductivity of polymers through an experimental setup that involved creating our own polymers through the use of two substances with different electrochemical reduction potential. By analyzing the current, the mass, and other factors, we can determine the conductivity of a polymer which informs us of its supposed chain length. The longer a polymer, the higher its conductivity level. We may not be able to accurately determine the length of the chain, however, we may be able to use two values to determine which is longer based on conductivity.

###### Experimental Procedure

Materials used:

* Power supply (0-10 V) to generate a current across the electrode
* Multimeter to measure the current
* 500 mL beaker to hold solution
* Indium Titanium Oxide (ITO) coated electrode and a copper electrode
* Pipettor to measure the volume of pyrrole
* 1.5 mL of pyrrole and 250 mL of pTS solution
* Stirring rod to homogenize the solution
* Latex gloves
* Digital caliper to measure the polymer film thickness
* Copper contacts to measure the film conductivity

Procedure:

1. Pour about 250 mL of the pTS solution into the beaker
2. Add 1.5 mL of the pyrrole to the solution using the pipettor
3. Stir the solution until the pyrrole drops are fully mixed in the solution
4. Measure the conductivity of each side of the ITO electrode to determine which side is the conductive coating
5. Connect the copper and ITO electrodes to the alligator clips making sure the conducting side of the ITO is facing the copper electrode
6. Immerse the electrodes into the solution; they should be about an inch apart. Do not allow the electrodes to touch during the experiment, as that would create a short-circuit and blow the fuse in the power supply. Do not immerse the alligator clips or the wires.
7. Connect the electrodes to the multimeter and the power supply according to Figure 3. Make sure the ITO glass electrode is connected to the positive side of the power supply.
8. Adjust the power supply to 2.5 V. Note this is constant voltage, not current voltage
9. Let the current run through the circuit for about 45 minutes while recording the values for current given by the multimeter every five minutes. As the polymer film is formed, you will see the ITO electrode turn black.
10. At the end of the experiment, turn off the power supply and carefully disconnect the electrodes. Gently wash them with distilled water and remove the black film in one solid piece as delicately as possible with a razor blade.
11. Air dry the film for at least 10 minutes.
12. Once dry, weigh the film and record the mass obtained. You will use this value to estimate the amount of polymer deposited.
13. Measure the thickness *t* of the film with the digital caliper.
14. Using the small copper contacts, measure the resistance of the film through its thickness.
15. Measure the resistance across a length *l* of the film. Record *l* and the obtained resistance R2.

Graphical user interface, text, application

Description automatically generated

###### Experimental Results

|  |  |
| --- | --- |
| **Time (min)** | **Current(A)** |
| 0 | 0.054 |
| 5 | 0.051 |
| 10 | 0.050 |
| 15 | 0.050 |
| 20 | 0.050 |
| 25 | 0.050 |

**Polymer mass**: 38.1 mg

**R1**: 80 Ω **R2**: 460 Ω

**l**: 3 cm

**A:** 0.49 cm2

**w**: 0.7 cm

**t**: 0.04 mm

###### Discussion and Conclusions

The conductivities are different due to the way the polymer is set up. You have two options for polymers, either a long chain or a short chain. The long chain is a lot more difficult to break and thus will have a larger conductivity value as it is able to conduct more electricity.