

Keywords: Poly(3-hexylthiophene-2,5-diyl), Organic Solar Cells, Chemical Oxidation Polymerization, Electrochemical Impedance Spectroscopy, Tafel Plot.

Introduction

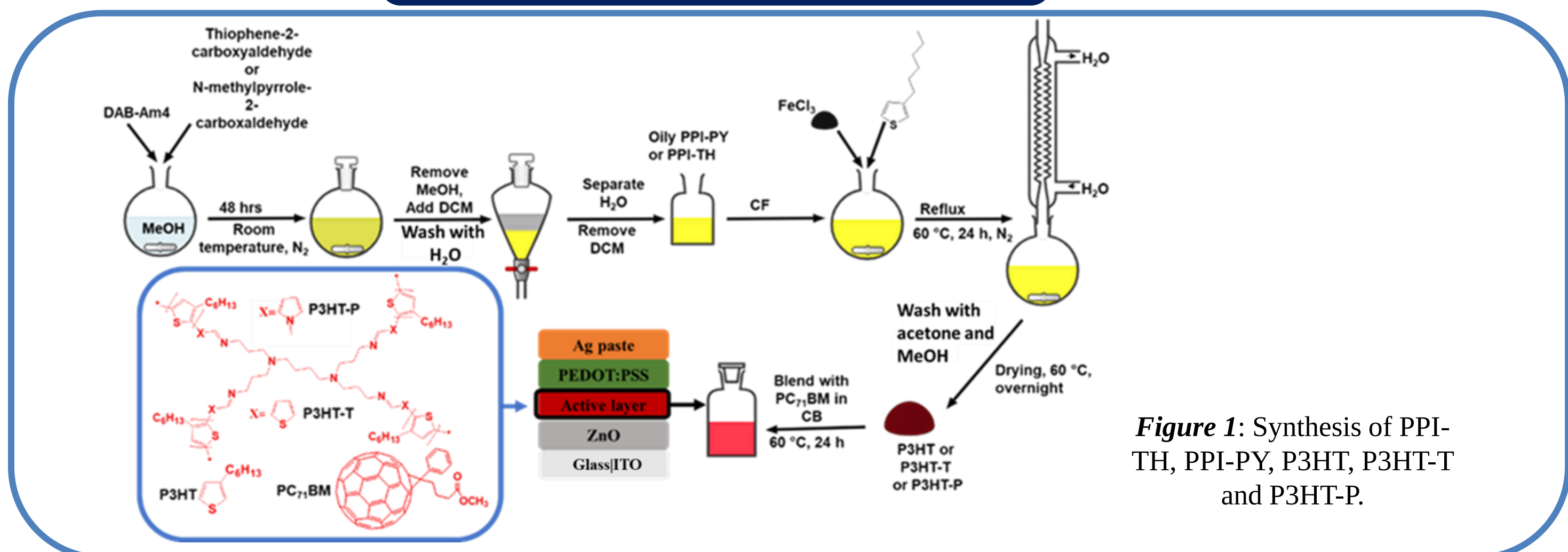
Currently, climate abnormality and environmental deterioration have become challenges to our society, especially in the developing countries. It is thought that the main cause of maddening global environment and climate issue is the combustion of fossil fuel during the conventional heat supply. For that reason, there is an urgent need to reduce the dependence on the use of fossil fuel by developing the renewable energy technology. As a source of clean energy, vigorous developments have been done on the photovoltaic cell in the past decades. However, photovoltaic cells suffer from lower power conversion efficiency.

In this work, we developed P3HT chains on the surface of thiophene functionalized polypropylenimine tetramine first generation dendrimer (PPI-TH) and N-methylpyrrole functionalized polypropylenimine tetramine first generation dendrimer (PPI-PY) using chemical oxidation polymerization. Structural characterization was conducted by using nuclear magnetic resonance spectroscopy (NMR) and Fourier-transform infrared spectroscopy (FTIR). Scanning electron microscopy (SEM) and thermal gravimetric analysis (TGA) were used for morphological and thermal stability studies, respectively. Ultraviolet-visible spectroscopy (UV-Vis) and photoluminescence were performed to study optical properties. Electrochemical responses were investigated using cyclic voltammetry (CV), electrochemical impedance spectroscopy and Tafel plots. We found that the OSCs based on poly(3-hexylthiophene-2,5-diyl)-co-thiophene functionalized polypropylenimine tetramine (P3HT-T), and poly(3-hexylthiophene-2,5-diyl)-co-N-methylpyrrole functionalized polypropylenimine tetramine (P3HT-P) have improved performance due to decrease in charge recombination and improved charge conductivity.

Objectives

- ✓ Synthesis of P3HT-T and P3HT-P
- ✓ Characterization of P3HT-T and P3HT-P
- ✓ Compare properties of P3HT-T and P3HT-P with P3HT
- ✓ Fabrication of OSCs.
- ✓ Analysis of OSCs.

Experimental design



Results and discussion

UV-Vis and PL Analysis of P3HT, P3HT-T and P3HT-P

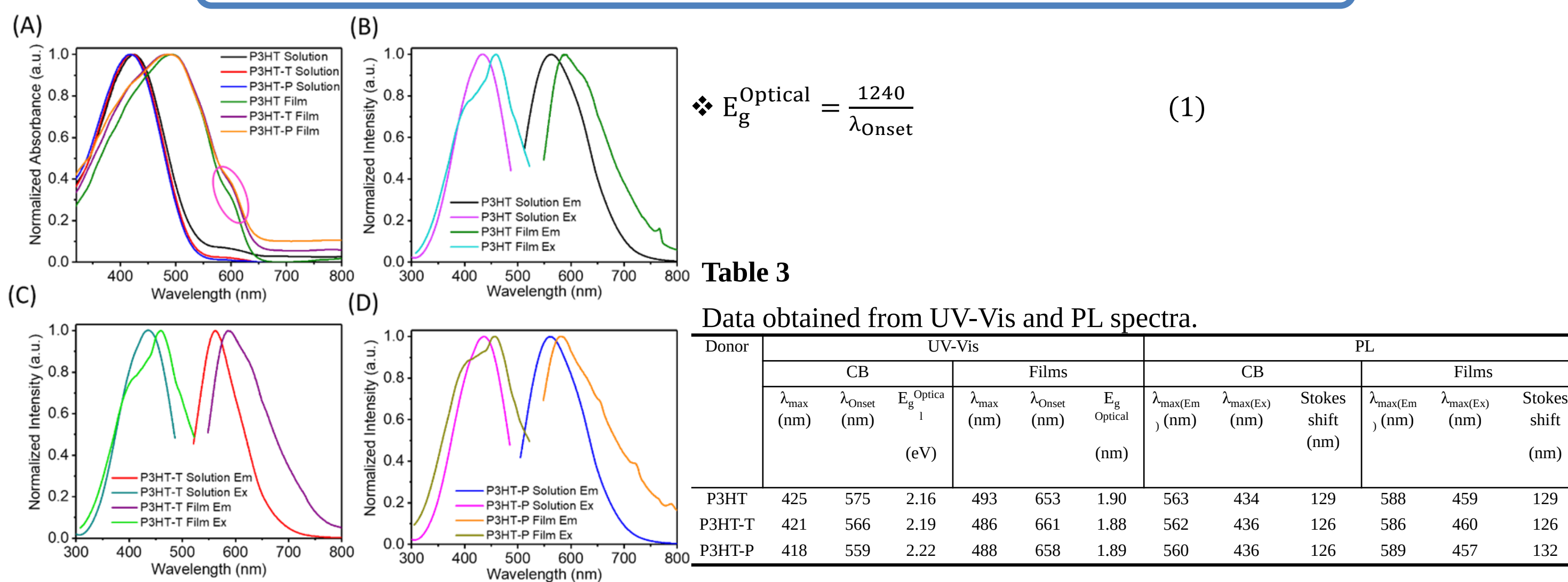


Figure 2: (A) UV-Vis absorption spectra of P3HT, P3HT-T, and P3HT-P as solutions and films prepared in CB. PL spectra of (B) P3HT, (C) P3HT-T, and (D) P3HT-P as solutions and films prepared in CB.

Electrochemical Analysis of P3HT, P3HT-T and P3HT-P

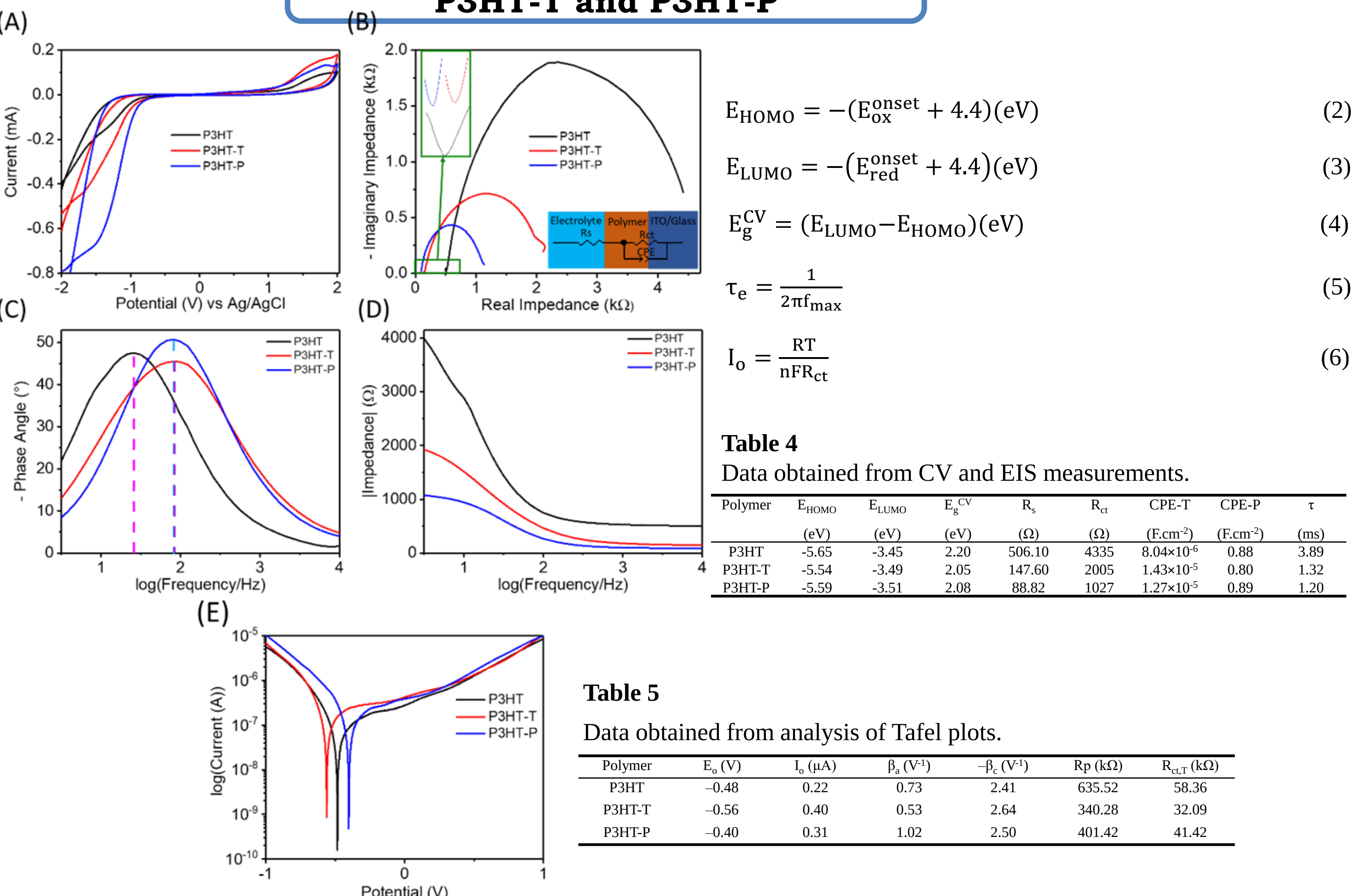


Figure 3: (A) CV, (B) Nyquist plot, (C) Phase-bode plot, (D) Impedance-bode plot and (E) Tafel plot of P3HT, P3HT-T, and P3HT-P in 0.1 M of NBu₄PF₆ solution in acetonitrile as supporting electrode. CV studies were obtained at a scan rate of 50 mV.s⁻¹, while EIS were conducted using a potential of -0.3 V.

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OSCs analysis

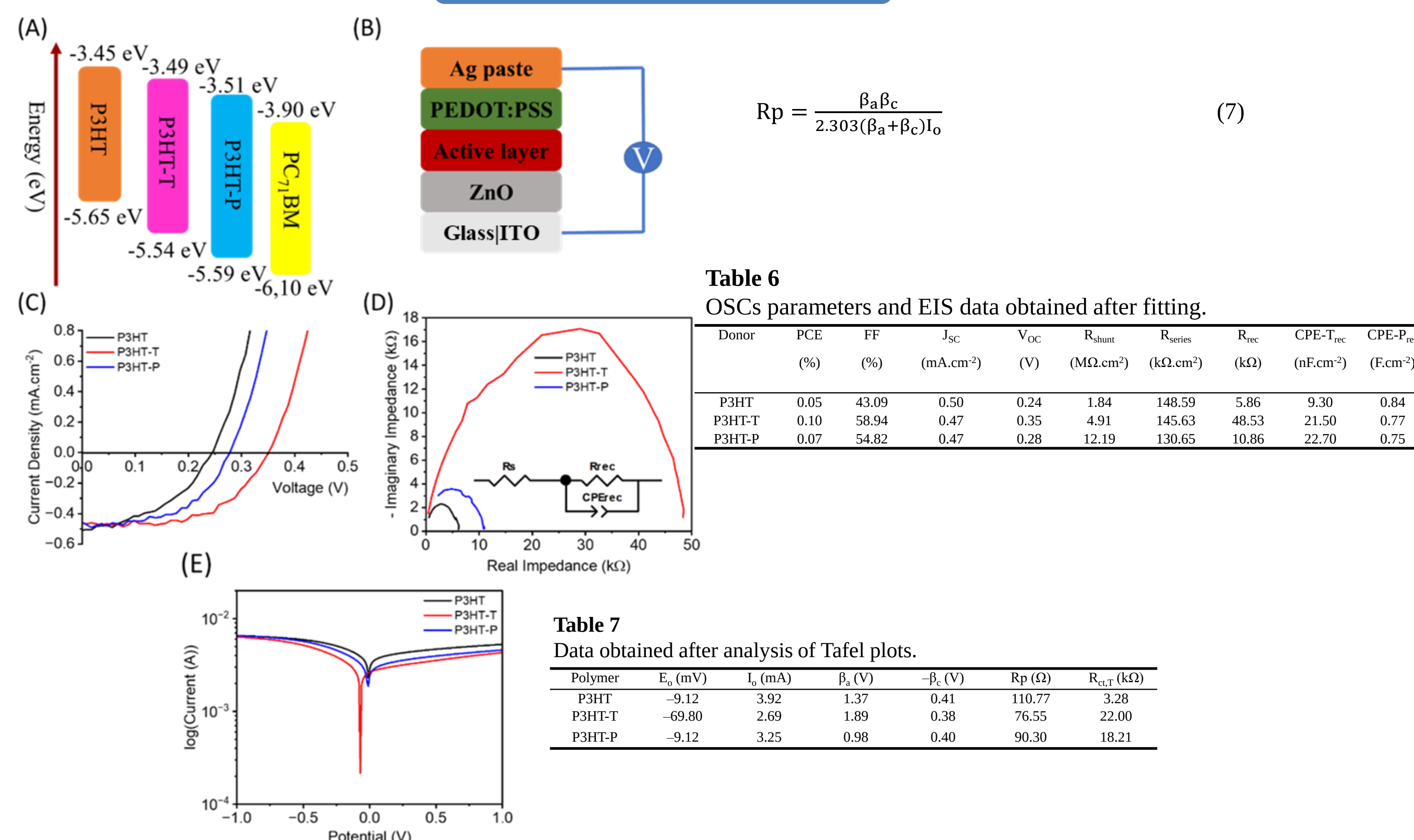


Figure 4: (A) HOMO-LUMO Levels, (B) Device Architecture, (C) J-V curves, (D) Nyquist plot and (E) Tafel plot of P3HT, P3HT-T, and P3HT-P OSC devices.

Conclusion

- ❖ Hyperbranched P3HT derivatives were successfully synthesized.
- ❖ After modification of P3HT, the optical band gaps of the synthesized polymers increased in CB and decreased as films.
- ❖ Deeper LUMO energy levels were obtained for P3HT-T and P3HT-P compared to P3HT.
- ❖ Parameters such as R_{ct} , τ_e , I_o , and R_p obtained from EIS and Tafel plot experiments suggest that P3HT-T and P3HT-P are more conductive than P3HT.
- ❖ The performance of OSCs recorded when P3HT-T and P3HT-P were used as donor materials are better than P3HT based device.
- ❖ These improvements in OSCs performance were assigned to the reduced charge recombination and increased charge transport resulting in an increase in V_{oc} and FF.

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