Carboxyl Alkyl Polythiophene for Organic Electrochemical Transistors

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Abstract:

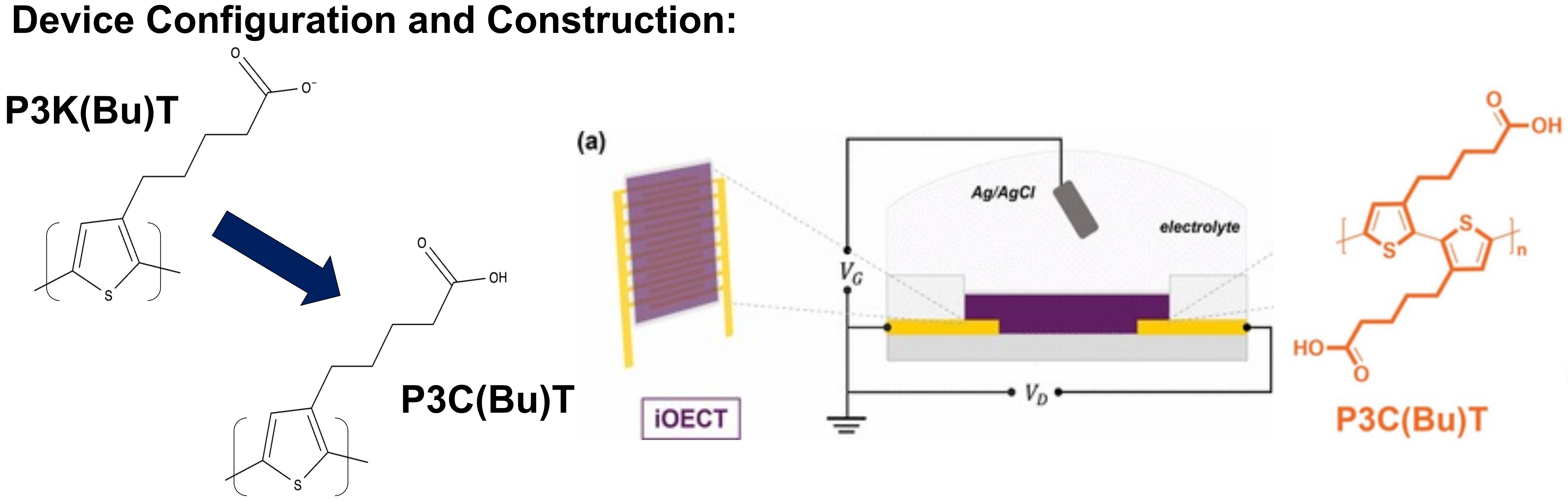
Transistors serve as fundamental circuit components that can amplify electric signals or act as a switch. Organic electrochemical transistors (OECTs) have emerged as a new technology with a wide range of potential applications. These devices consist of a gate, drain, and source electrode, similar to organic field effect transistors (OFETs). However, the gate electrode is submerged in an electrolyte that covers a thin layer film of a conjugated polymer, known as an organic mixed conductor, across the transistor channel. This OECT structure allows for ion movement from the electrolyte through the polymer film, leading to a significant change in channel conductance.

For this study, the use of carboxyl alkyl polythiophene (P3C(Bu)T) as the thin film polymer for OECTs is being explored. This polymer exhibits both hydrophilic and hydrophobic components due to alkyl spacers in the conjugated backbone and the ionic functional end group, respectively. The processing of the polymer is achieved through an acid treatment of methanol and p-toluenesulfonic acid completed after the spray coating of the water-soluble polymer precursor.

P3C(Bu)T has exhibited promising performance, specifically in the characterization of output and transfer curves. The transfer curve, depicting the relationship between gate voltage and drain current, exhibits a high efficiency of transconductance. Further analytical techniques have confirmed the findings of the relative stability of P3C(Bu)T, indicating that future works with this polymer could be a viable avenue for further OECT development.

Methods:

Device Configuration and Construction:



- P3C(Bu)T is dissolved in water, then the solution is spray-coated onto a gold-interdigitated electrode platform for OECT testing or onto conductive glass for cyclic voltammetry testing
- After being spray coated, samples are acid-treated to create hydrophobic alkyl spacers in the polymer

Acknowledgements and References:

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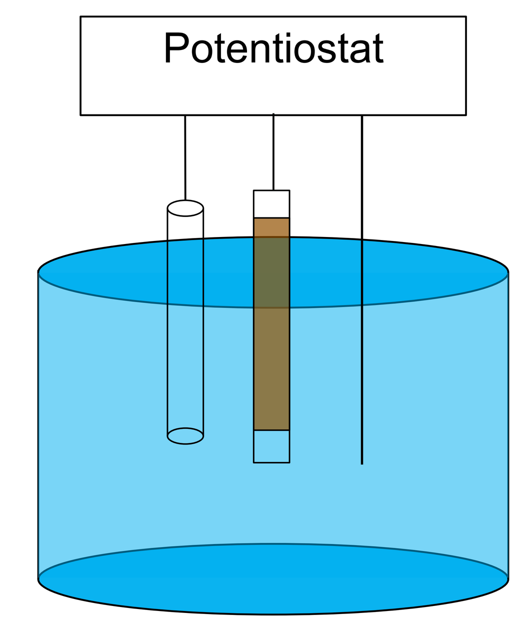
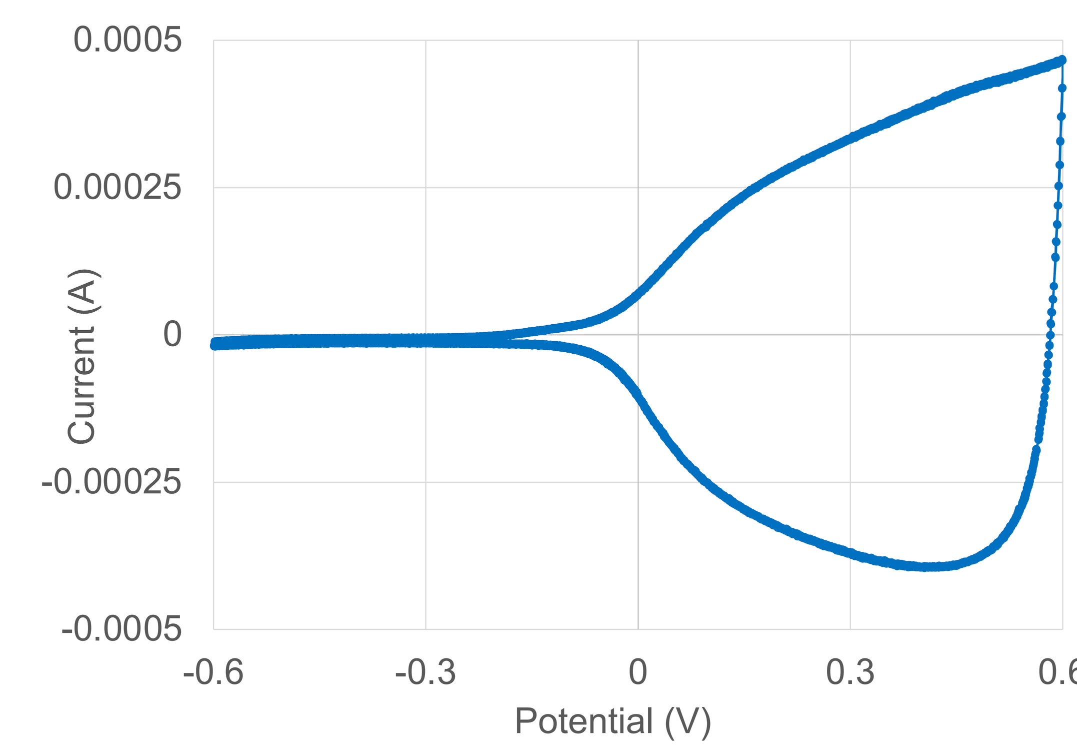
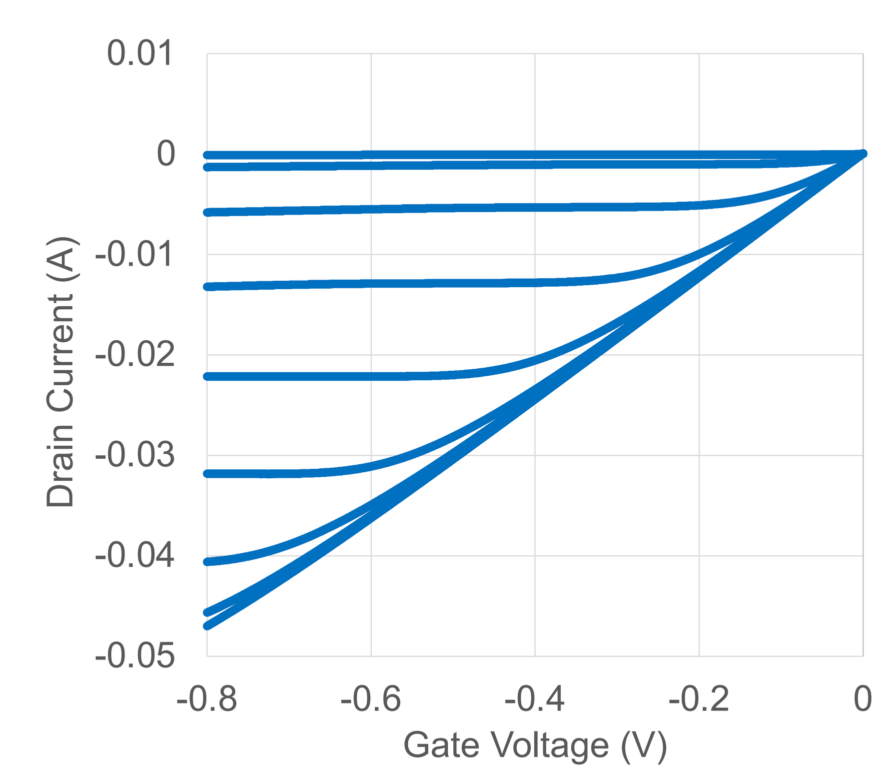
P3C(Bu)T Electrochemistry





- In cyclic voltammetry measurements, a small section of conductive glass is spray-coated with P3C(Bu)T, then acid-treated
- Samples were immersed in KCl solutions, and cyclic voltammetry measurements were used to confirm polymer conduction

OECT Output Curve:



- Output curve testing is used to determine the optimal source voltage for transfer curve testing
- Each curve represents the drain current vs the get voltage at constant source voltage levels

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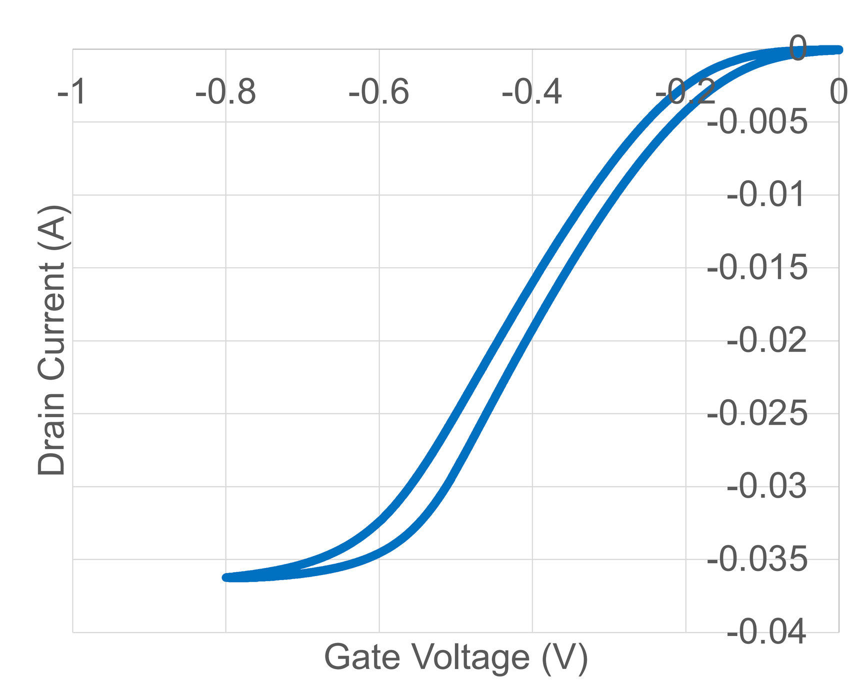
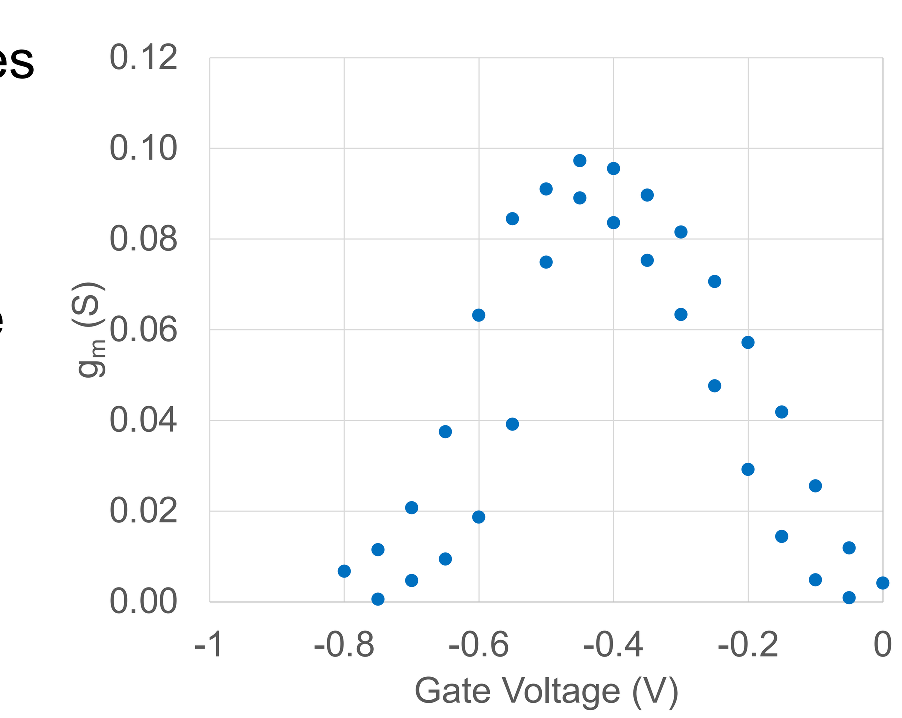
OECT Transfer Curves:



- Transfer curve testing examines the drain current vs the gate voltage at a constant source voltage level
- Derivative of the transfer curve displays transconductance vs gate voltage of the P3C(Bu)T OECT
  - Describes how effectively transistor can amplify signal



Future Works:

- Exploring and comparing different polymers and different synthesis techniques for OECT
- OECTs have a wide range of applications from bioelectronics to biosensors/implantable technologies