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INKJET-PRINTED ORGANIC REDOX TRANSISTORS FOR NEUROMORPHICS AND NEURAL INTERFACING

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MOTIVATION

As computing begins to shift towards neural mimicry, hardware must be developed to compliment the next generation of computing [1]. While traditional transistors are digital, the device we demonstrate allows for an analogue response that is necessary for this technology. Utilizing the biocompatibility and low-cost fabrication of PEDOT and the scalability provided by an inkjet fabrication platform, we demonstrate the first ink-jet printed organic redox transistor.

REDOX TRANSISTORS

a)

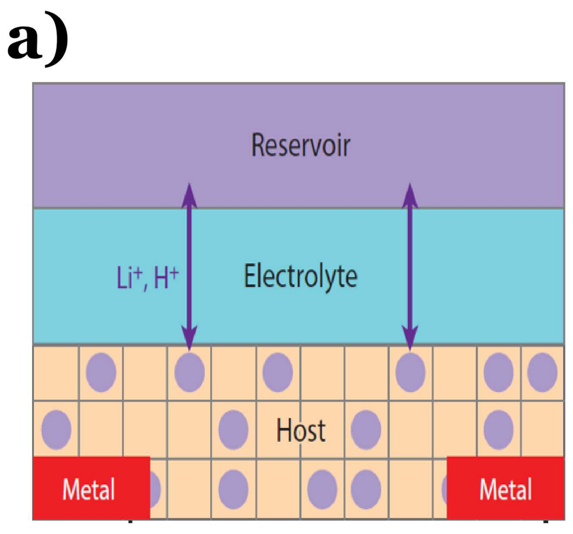


Fig a) General Redox Transistor Device Architecture [2]

b)

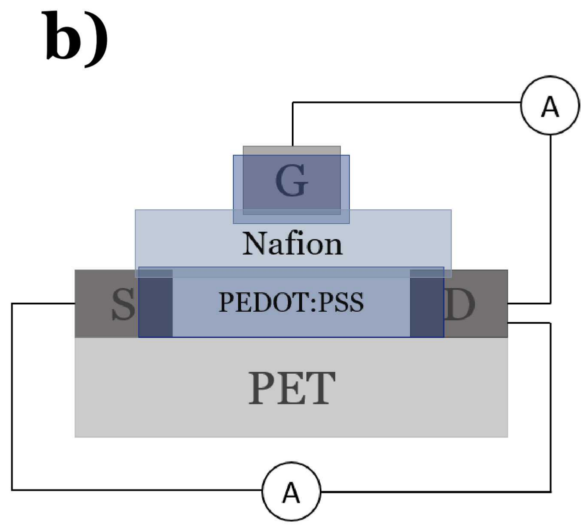


Fig b) Inkjet-Printed Organic Redox Transistor Device

c)

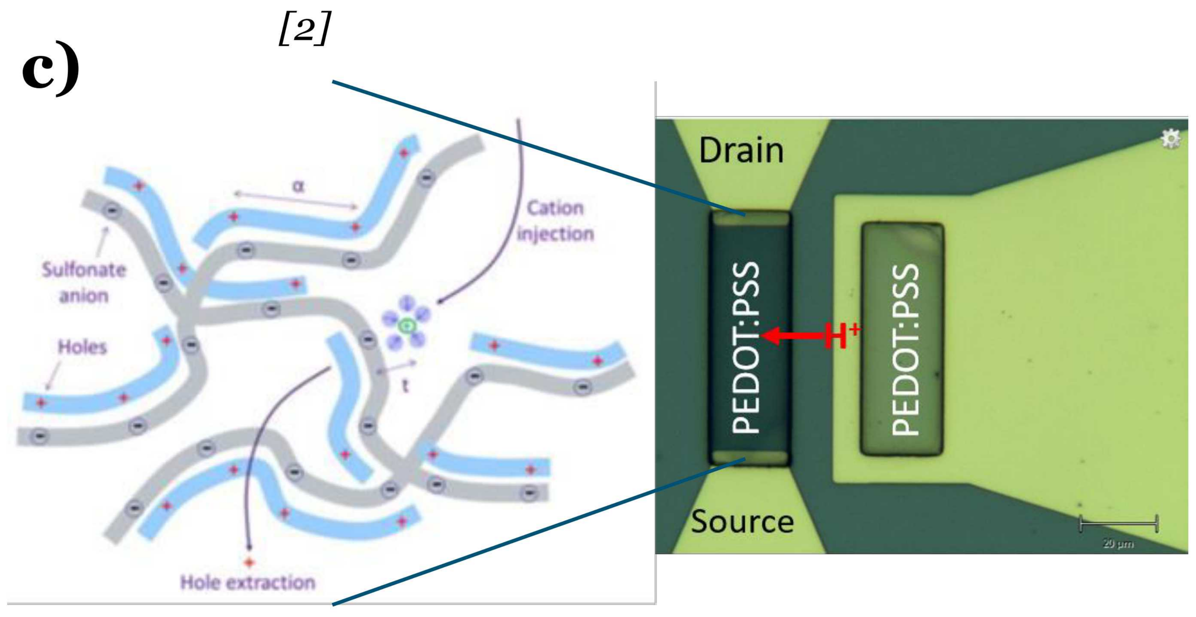


Fig c) Electrochemical Mechanism in Organic Redox Transistor Device

- Redox transistors rely on ion-insertion to electrochemically modulate conductivity
- Nafion is a polymer proton-conductor
- PEDOT reversibly modulates conductivity through a compensation mechanism with PSS

INKJET-PRINTING

d)

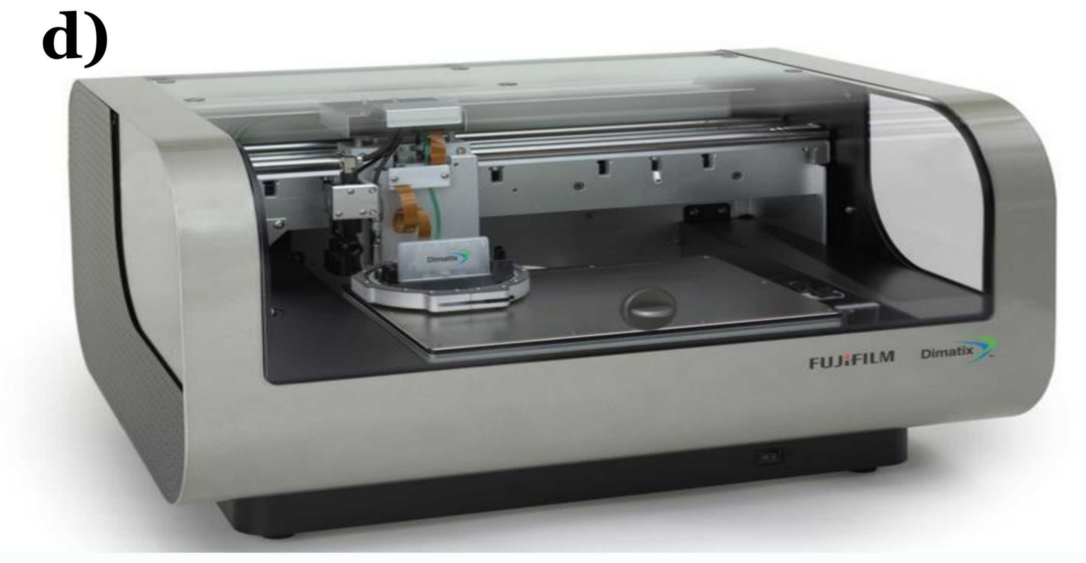


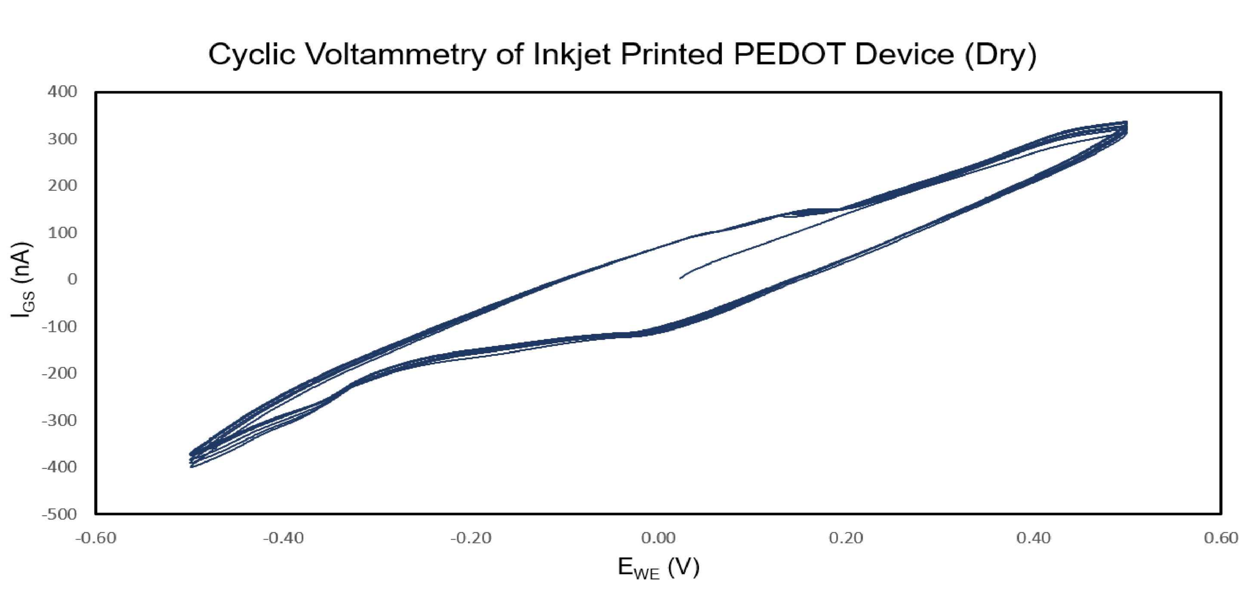
Fig d) Fujifilm Dimatax Inkjet Printer

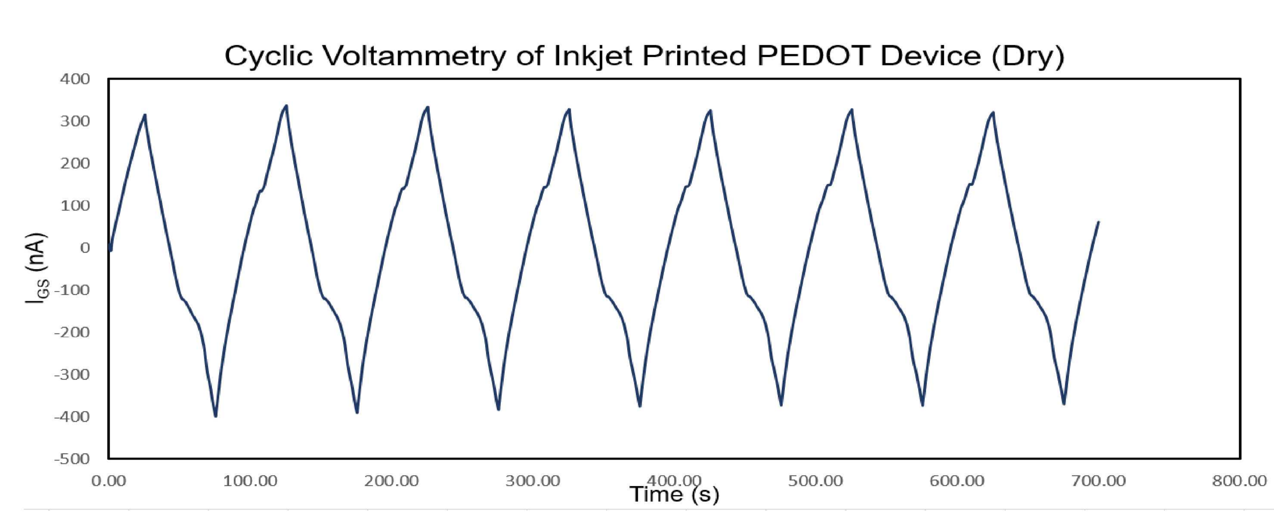
- Inkjet printing provides solution-processed films that are scalable
- Highly conductive Ag electrodes could be printed with a single layer of material
- PEDOT ink absorbs well onto flexible substrate

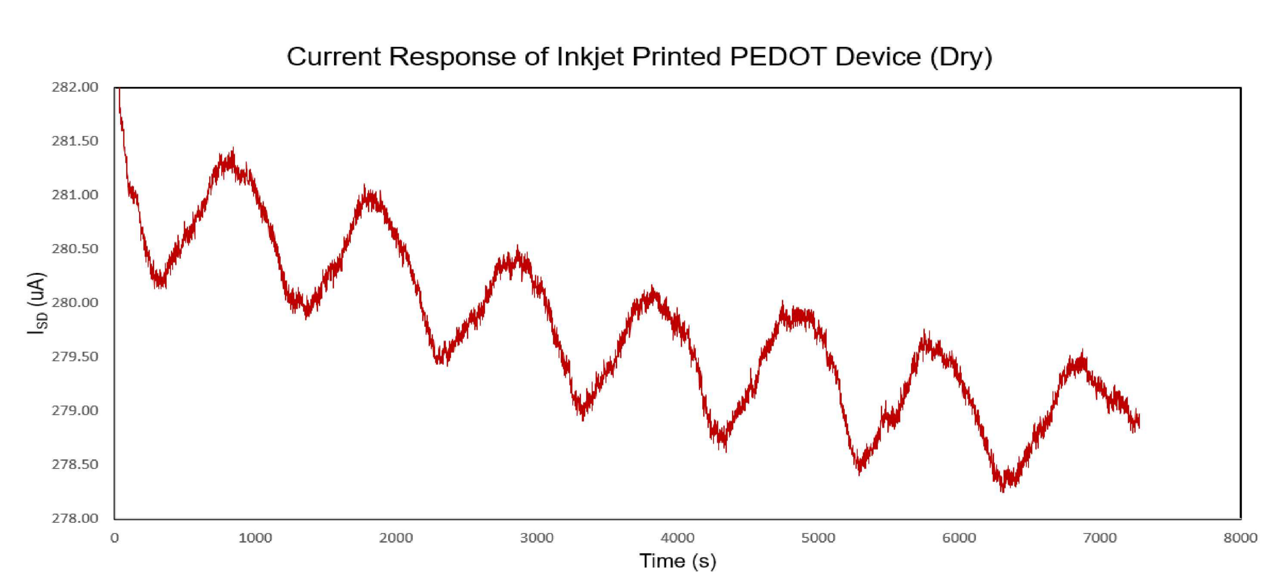
IMPORTANCE OF DEVICE

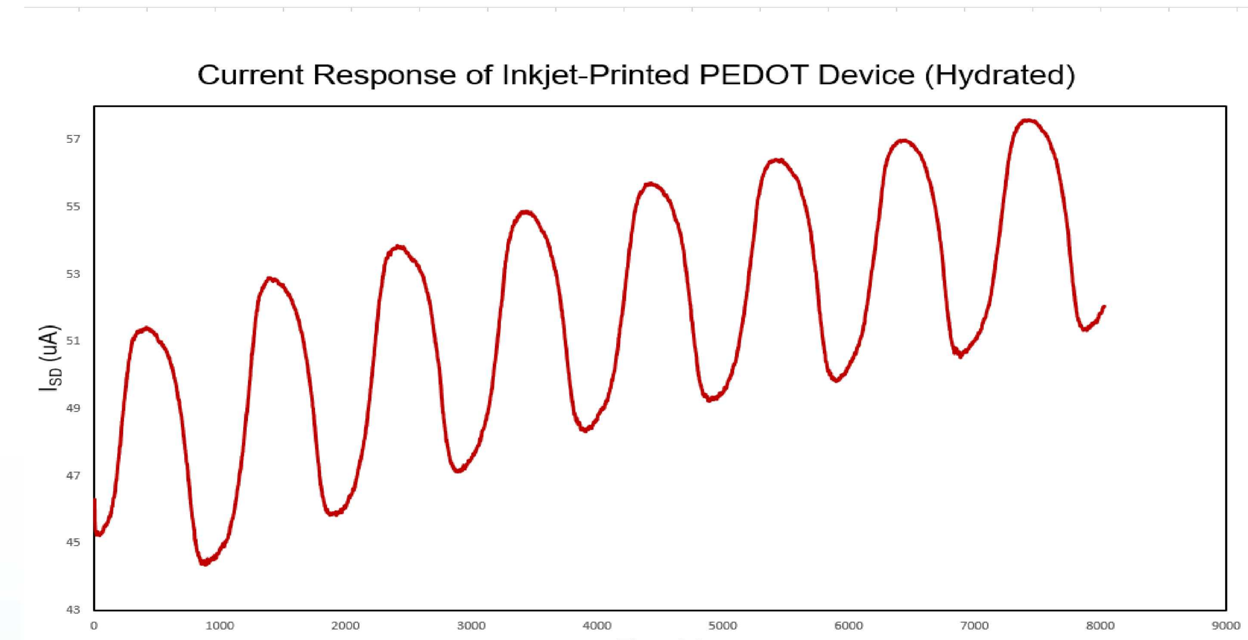
- Organic Device (PEDOT:PSS) →
  - Synthetically Tunable
  - Low-cost Fabrication
  - Biocompatible
- Redox Transistor →
  - Ion-insertion switching
  - Analogue Operation
  - Saves Read/Write State
- Inkjet-Printed →
  - Scalable
  - Solution-Processed Film
- Applications →
  - Neuromorphics
  - Neural Interfacing
  - Biosensors

DEVICE CHARACTERIZATION



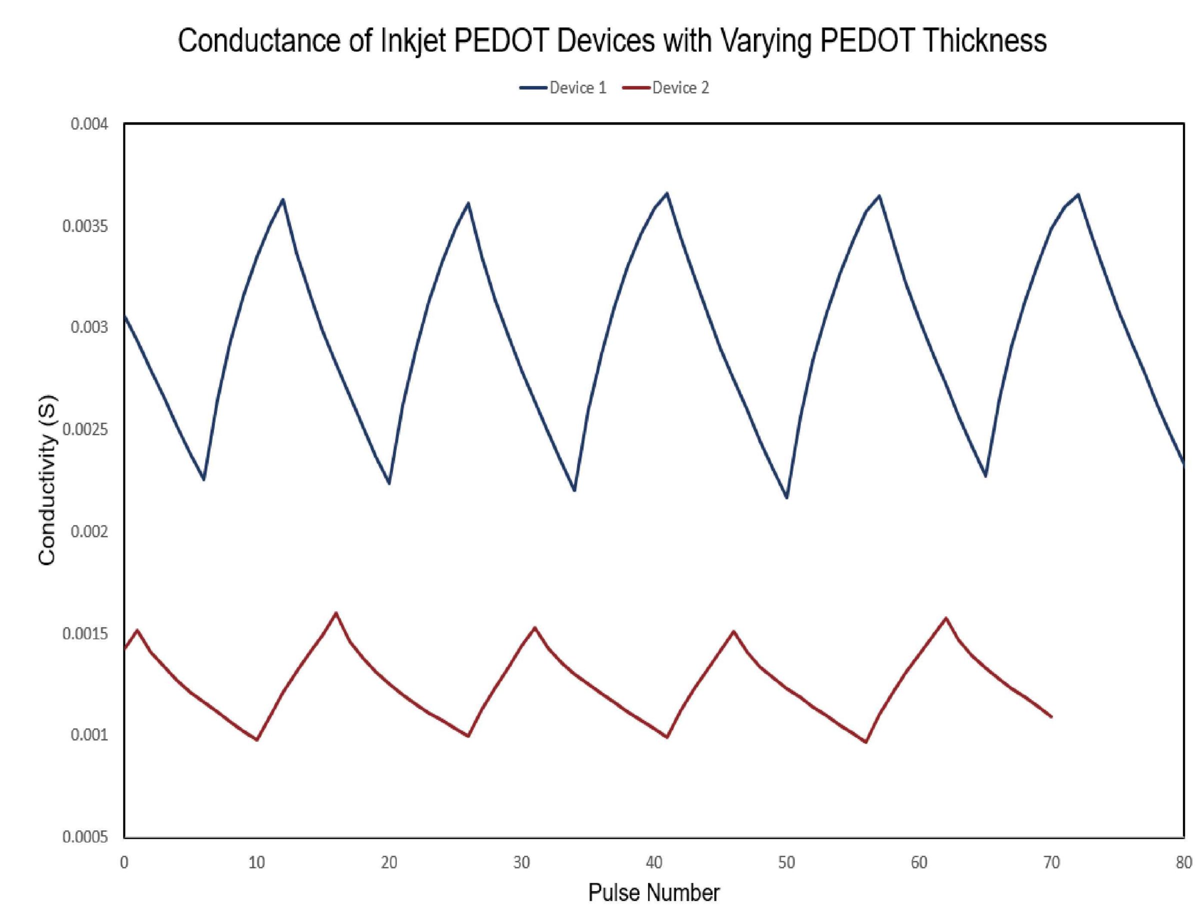






- Cyclic Voltammetry (CV) and Current vs. time response were measured
- Dry device was highly conductive but did not allow for large modulations of current (~2 uA)
- Hydrated device allowed for greater control of the modulation of current (~10 uA)

IMPACT OF PEDOT THICKNESS



- Two devices were inkjet printed with varying thickness
- Device 1 (10 layers) and Device 2 (3 layers)
- A greater PEDOT thickness results in a larger conductance and greater capability to modulate current
- Indicates that thickness of the PEDOT plays an important role in the operation of the device

CONCLUSIONS & FUTURE WORK

- Inkjet-Printing provides consistent fabrication method of organic redox device
- Device demonstrates the capability to reversibly modulate conductivity and conductance states
- The analogue response of this device makes integration into neuromorphics a natural next step
- A dopamine biosensor will also be developed utilizing this device

ACKNOWLEDGMENTS

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