7TH INTERNATIONAL CONFERENCE

Scientific and Research Cooperation between Vietnam and Poland

18–20 October 2023, Kraków, Poland

POL-VIET 2023

Polyaniline and Polythiophene Electrodes for High-Performance Supercapacitors

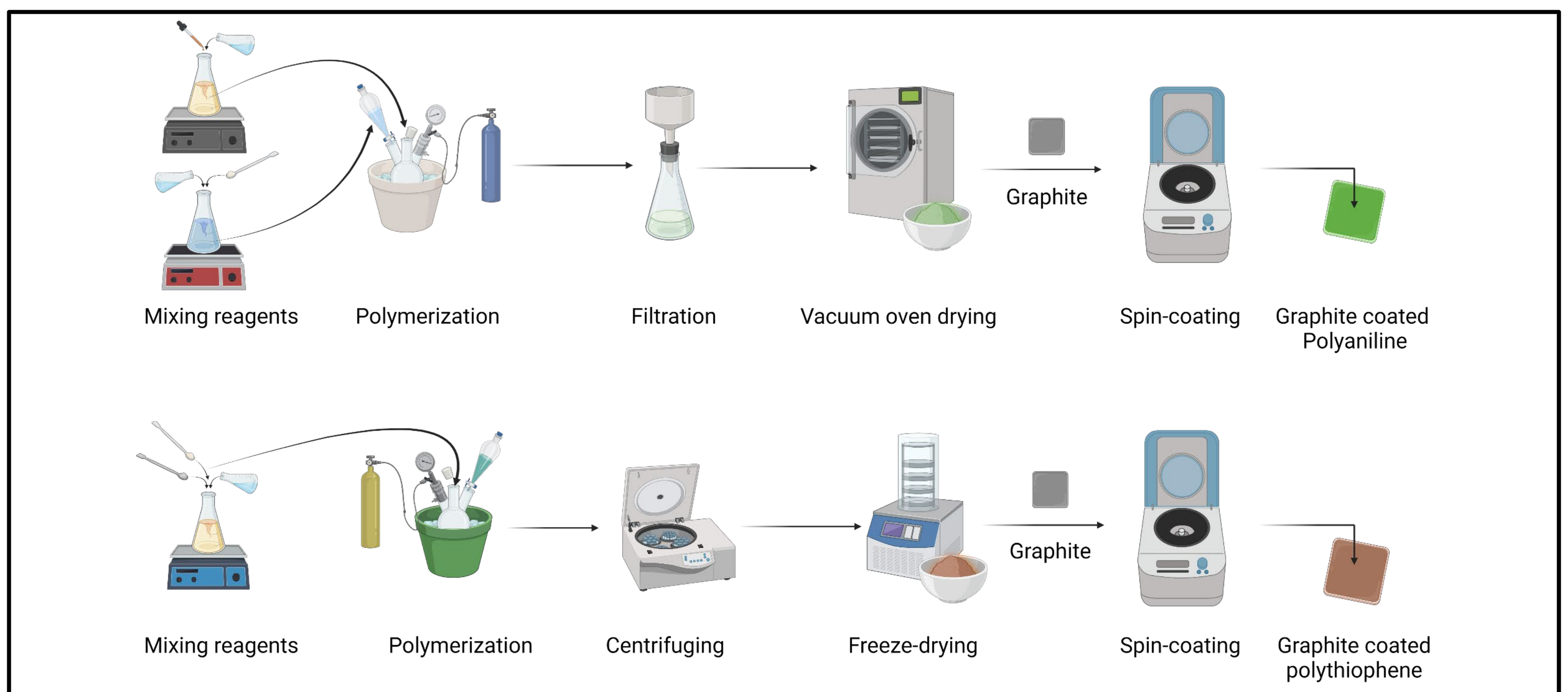
Mohammad Ali Haghighat Bayan, Filippo Pierini

Introduction

- ***High-Performance Energy Storage*** are advanced devices that can excel in rapid energy storage and release.
- ***Electrostatic Energy Storage:*** unlike batteries, they store energy electrostatically. This allows for quick charge and discharge cycles.

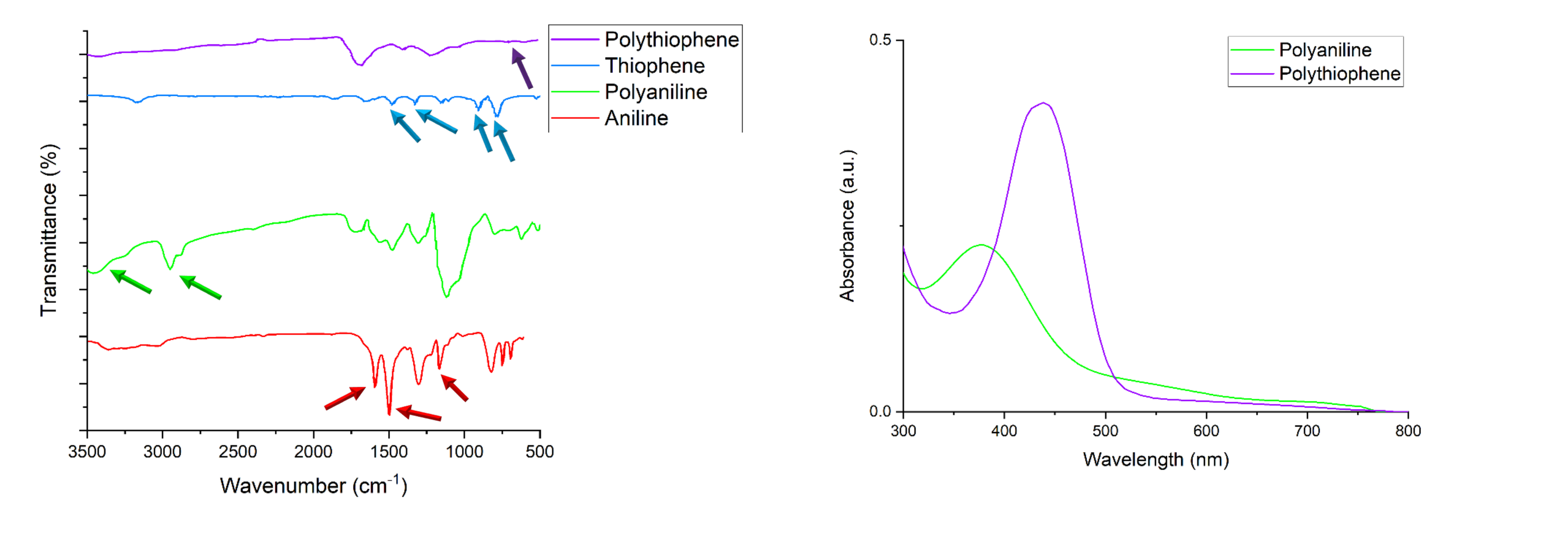
Methods

- ***Polymerization Process:*** Conducting polymers are synthesized through a polymerization process. Monomer molecules undergo chemical reactions to form long chains or networks.
- ***Doping for Conductivity:*** Conducting polymers are doped with various dopant molecules to impart conductivity. Doping introduces charge carriers (e.g., electrons or holes) into the polymer structure.
- ***Versatile Techniques:*** Various methods, such as chemical oxidative polymerization, can be used. Electrochemical and photochemical techniques are also common for synthesis.



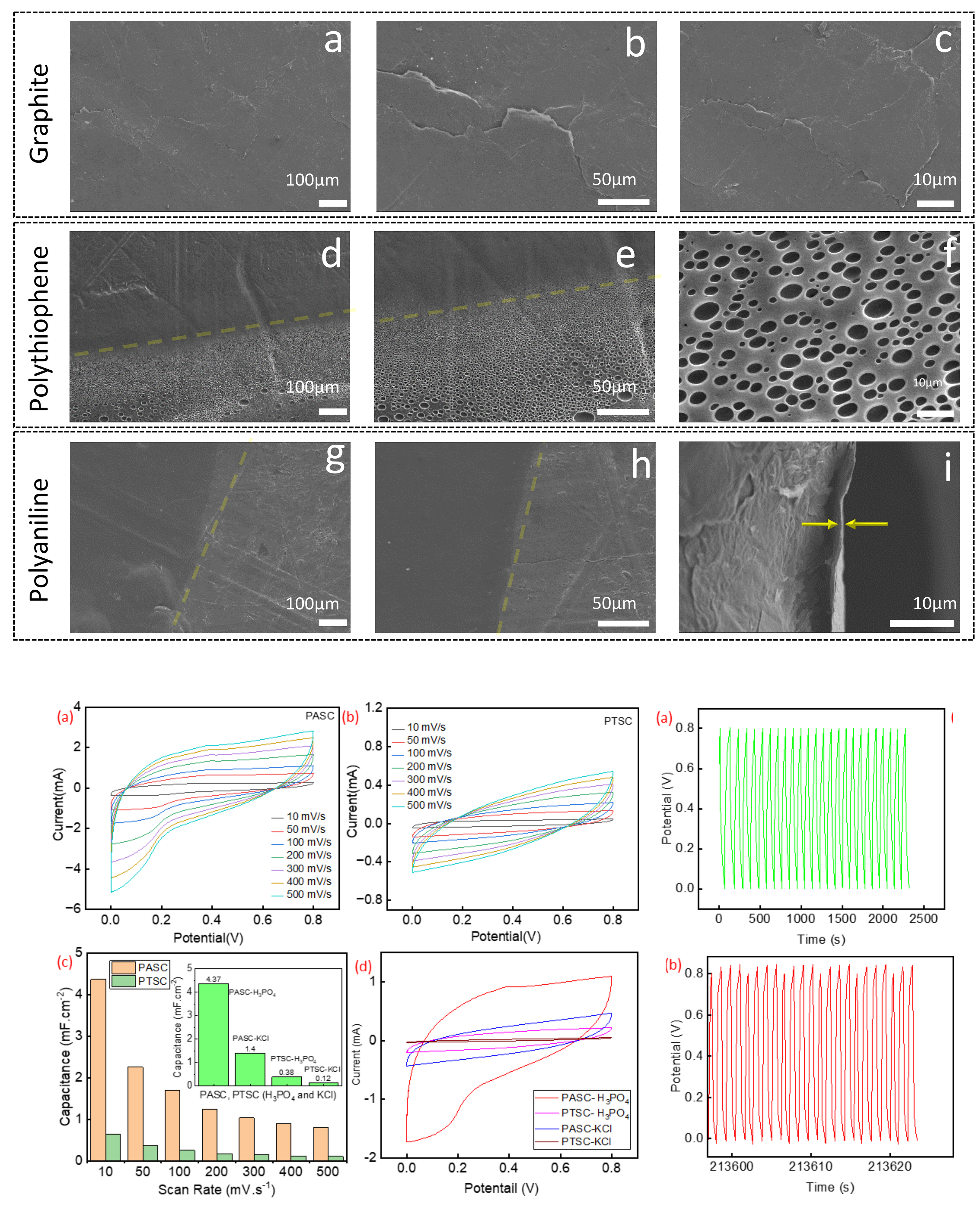
Chemical Characterizations

- PANI's FTIR spectrum (1146, 1439, 1570 cm^{-1}) shows quinone nitrogen vibrations, benzene stretching modes, and configuration changes. Thiophene's spectrum (2916, 1674, 1404, 1211, 1041 cm−1) displays C-H and C=C stretching, C-H bending, and C-S bending. These results confirm monomer polymerization.
- UV-Vis spectrum shows a sharp 365 nm absorption peak indicating its conductive emeraldine form for PANI. Polythiophene UV-Vis spectrum displays 446 nm peak, confirming stable polymerization without thiophene degradation.



Morphology

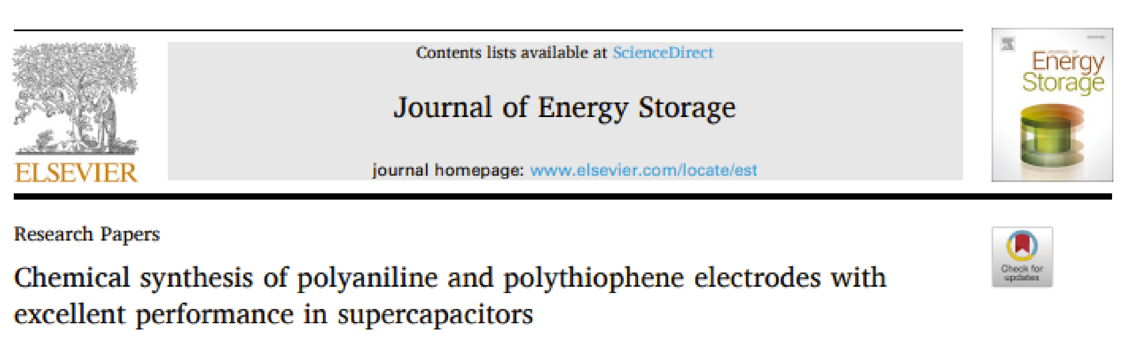
- SEM micrographs depict the surface morphology of conjugated polymer-coated layers. The graphite sheet (a-c) had a flake-type structure, and polythiophene exhibited a porous structure, while PANI had a non-porous spin-coated layer.
- Polythiophene (d-f) showed a porous network due to solvent evaporation, with an average pore diameter of 159.04 μm ± 61.89. Scratching some areas enhanced visibility.
- PANI coating (g-p) was uniform and thin without pores, with an average thickness of 401 nm.



Conclusions

- Specific capacitance: 13.22 mF cm^{-2}
- Energy density: 1.175 μW h cm^{-2}
- Power density: 4.99 μW cm^{-2} at 50 μA current
- Compared to PTSC, PASC exhibits four times higher capacitance due to superior surface, structural, and electrical properties.
- Electrochemical impedance analysis (0.1 Hz to 100 kHz) reveals faster ionic exchange and higher PASC capacitance than PTSC in the H3PO4 electrolyte.
- Hydrophobicity affects polythiophene's performance, influencing the electrode-electrolyte interface.
- PANI coating provides a uniform thin film, reducing resistance compared to polythiophene and improving energy storage.
- This preparation method enhances supercapacitor performance.

Future studies will explore electrolytes (acidic, alkaline, neutral, and ionic liquids) for further optimization.



Contents lists available at ScienceDirect

Journal of Energy Storage

journal homepage: www.elsevier.com/locate/est

ELSEVIER

Research Papers

Chemical synthesis of polyaniline and polythiophene electrodes with excellent performance in supercapacitors