

Electrical and Structural Characterization of Graphene-Polypyrrole Composite Thin Films for Flexible Wearable Electrodes

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INTRODUCTION & AIM

The aim is to develop composites suitable for flexible, gel-free wearable ECG electrodes with balanced conductivity and mechanical robustness.

Polypyrrole (PPy) is a promising conductive polymer for wearable bioelectronics due to its electrical conductivity and flexibility; however, its mechanical stability under deformation remains a challenge.

This work investigates PEG modification and graphene incorporation into PPy-TSA thin films to tailor their electrical and mechanical properties.

PROBLEM

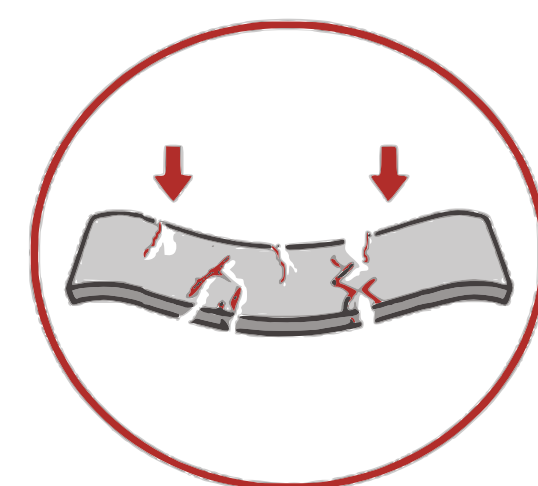
OBJECTIVE



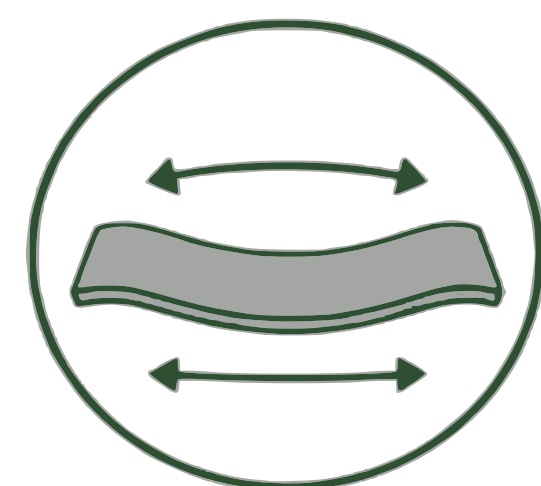
Poor signal stability
under mechanical deformation



Stable acquisition
signal integrity maintained during deformation



Mechanical fragility
cracking and loss of structural integrity



Mechanical Robustness
withstand mechanical strain while maintaining integrity



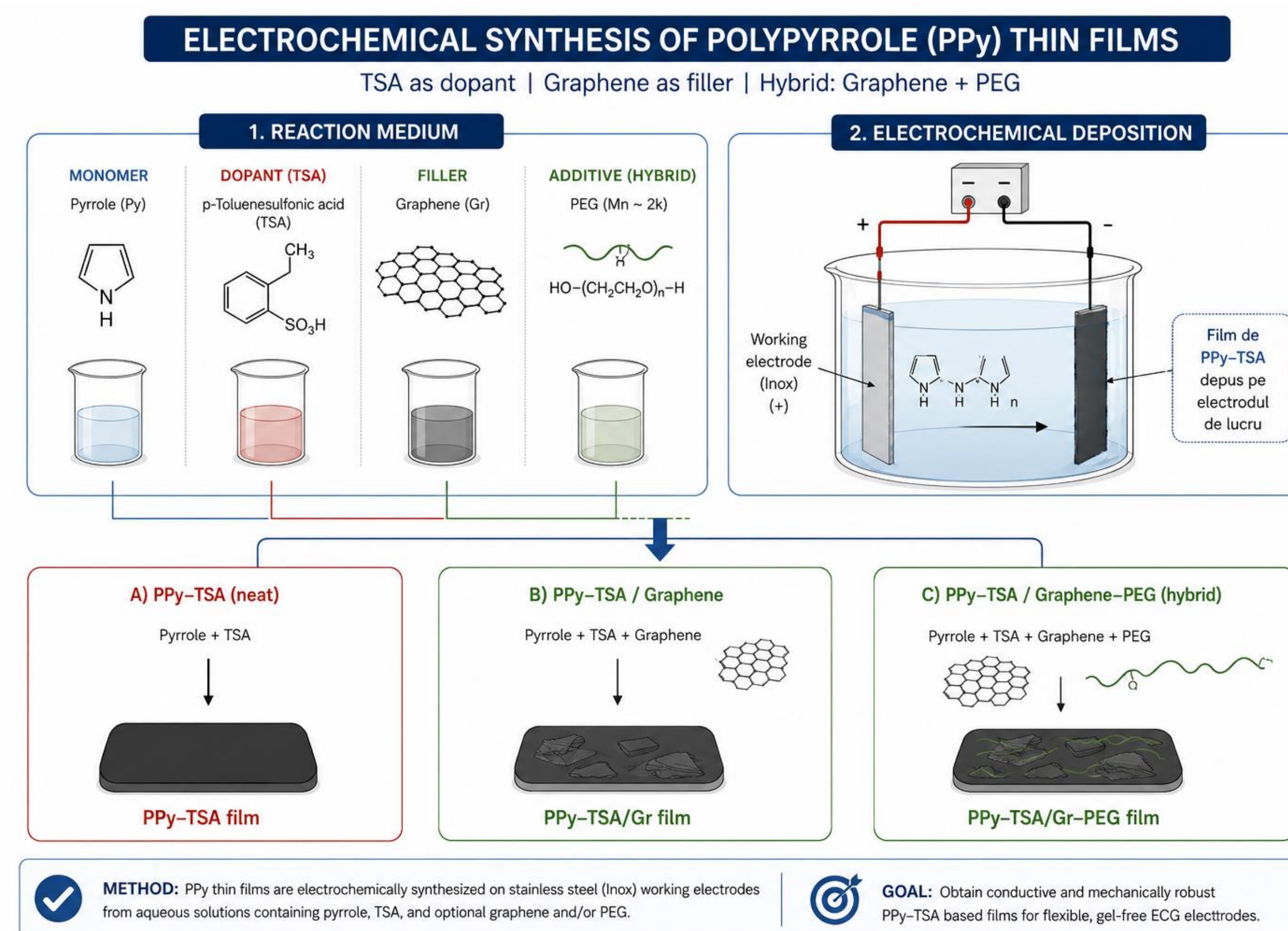
Property trade-off
high conductivity but limited mechanical stability



Reliable performance
enabling long-term, gel-free flexible ECG electrodes

METHODS

PREPARATION



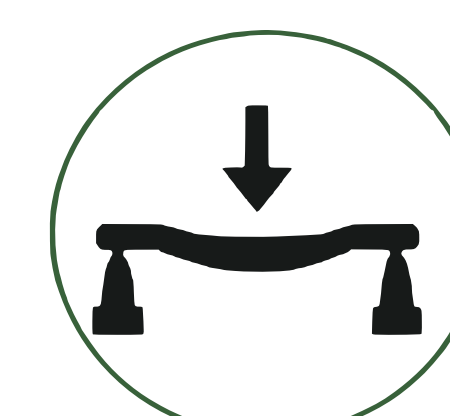
CHARACTERIZATION WORKFLOW



Electrical Conductivity
at 25 °C



Thermal Response
in the range 25 to 85 °C

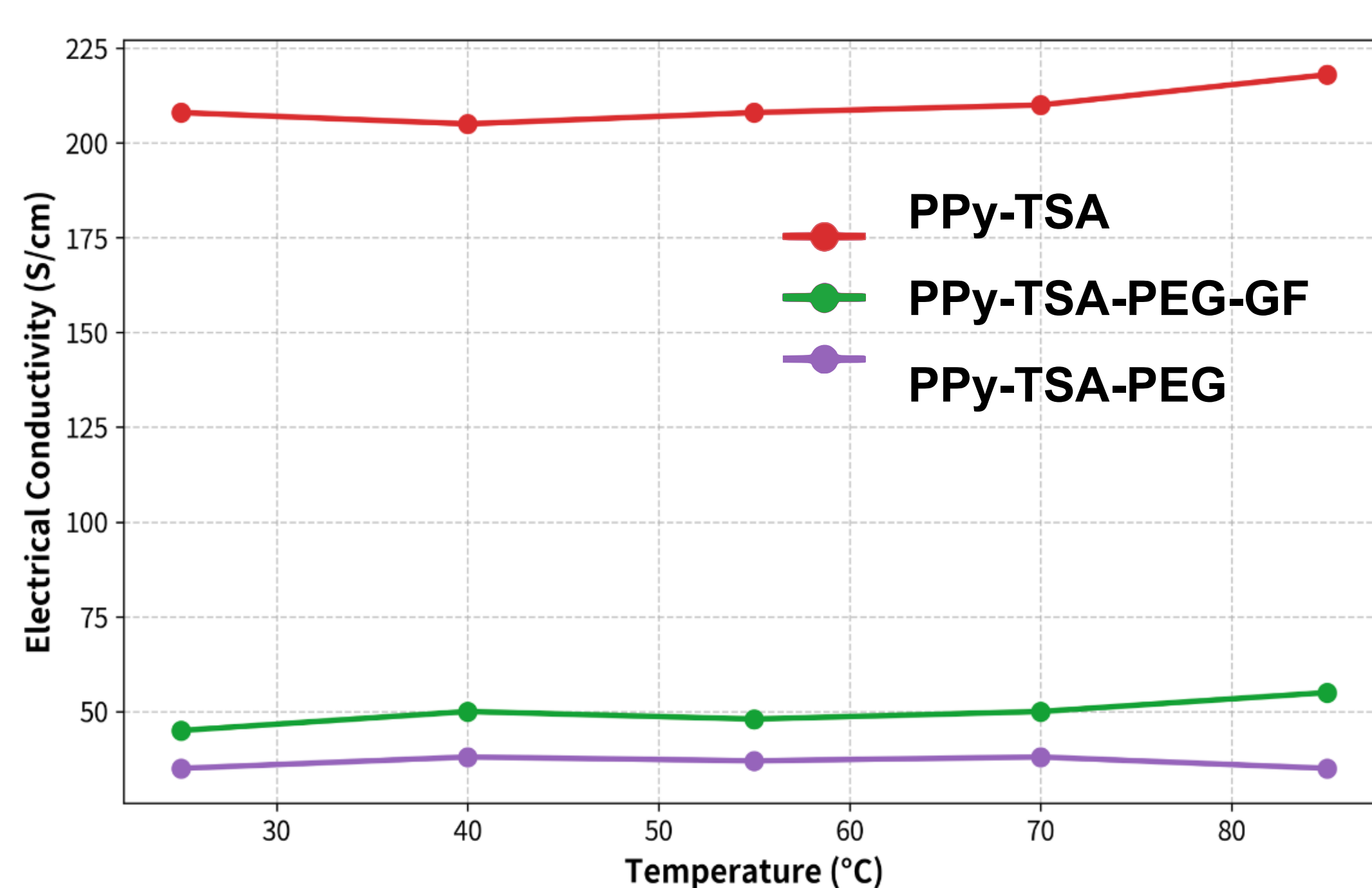


Mechanical Response
flexibility assessment

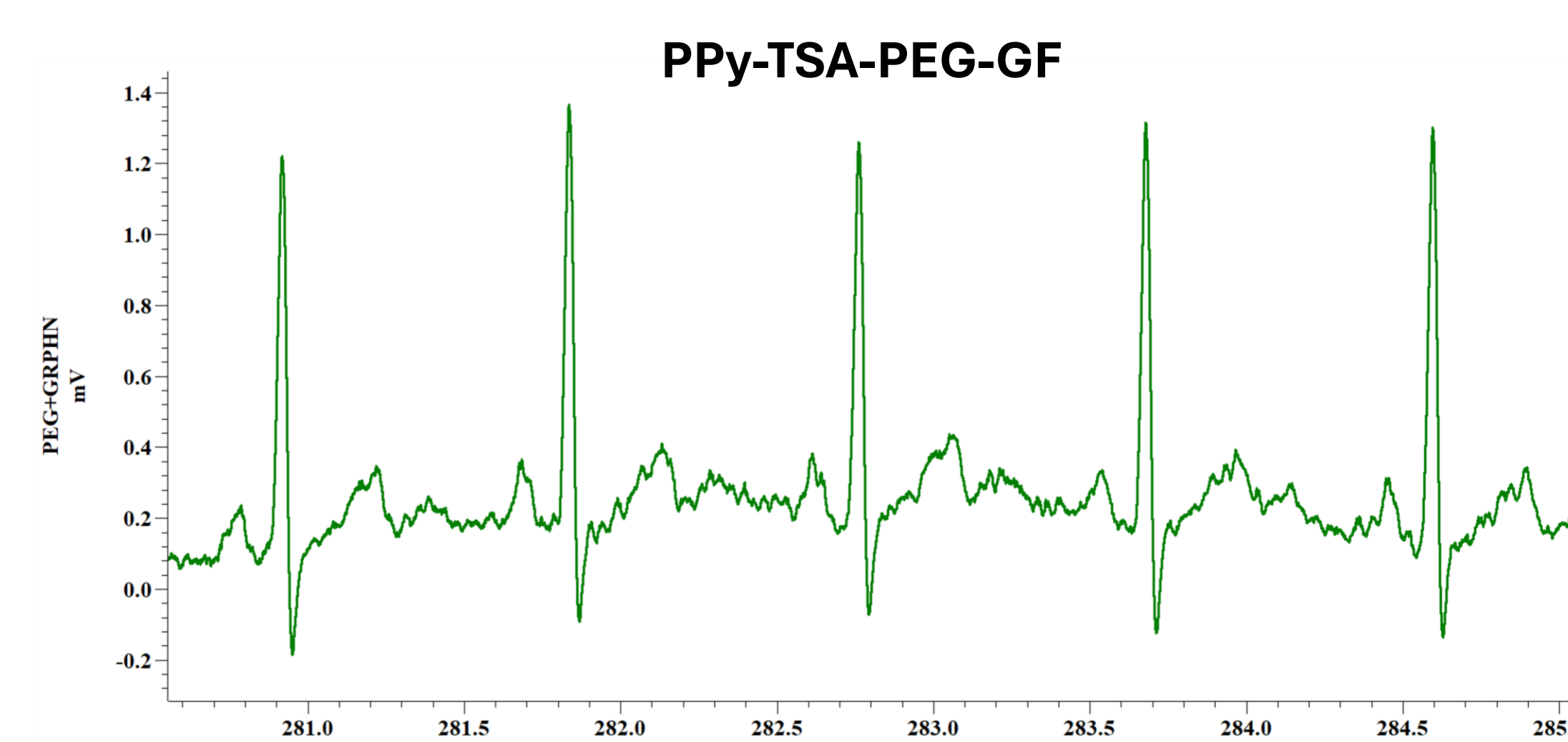
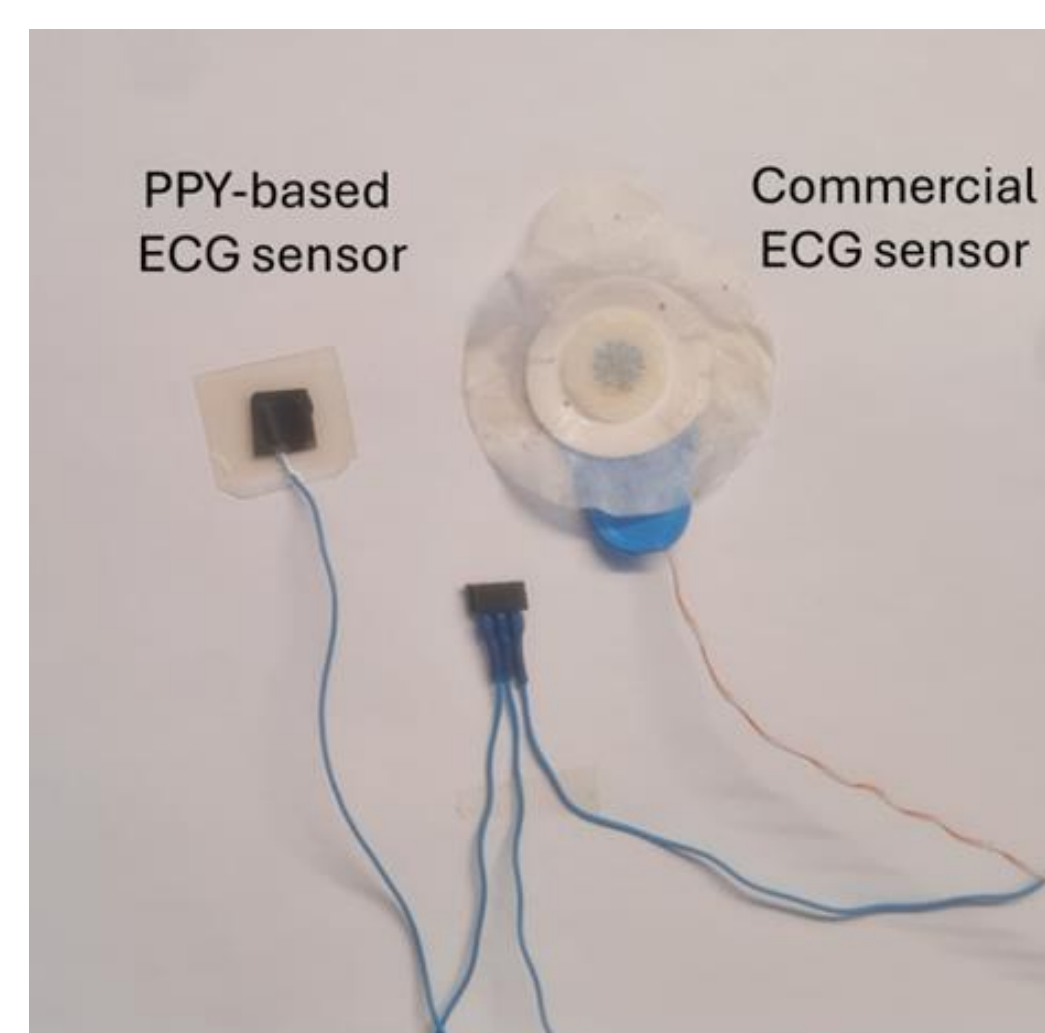


Charge Transport
structural correlation

RESULTS & DISCUSSION



Sample name	Electrical Conductivity (S·cm ⁻¹) at 25 °C
PPY-TSA	208 ± 16
PPY-TSA-PEG-GF	43 ± 4
PPY-TSA-PEG	38 ± 3
PPy-TSA-GF	62 ± 3



CONCLUSIONS

- ✓ PEG enhances flexibility, while graphene improves mechanical stability and partially preserves conductivity.
- ✓ PPy-TSA-PEG-GR offers the best balance of conductivity, flexibility, and robustness.
- ✓ The hybrid composite is a promising material for flexible, gel-free wearable ECG electrodes capable of real-time signal monitoring.

FUTURE WORK

- Optimize graphene loading for enhanced conductivity
- Evaluate fatigue resistance under repeated bending
- Develop wearable ECG electrode prototypes
- Assess long-term physiological stability

ACKNOWLEDGMENT

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