Flexible Thermoelectric Materials Based on Conducting Polymers

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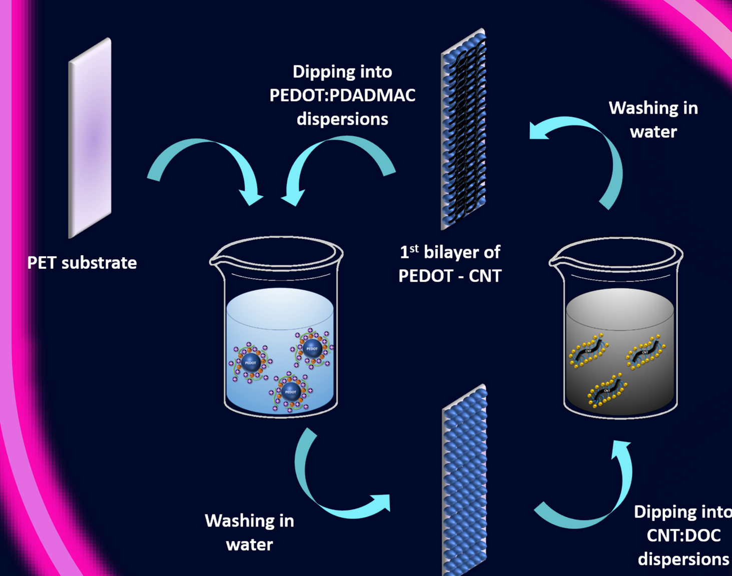
1. Introduction

With the growth of wearable technology and the spread of the Internet of Things (IoT), it is of vital importance to develop energy sources that can supply power to these small devices without the need to be constantly recharged. Obtaining thermoelectric generators (TE) can solve this problem since they are capable of obtaining electrical energy from a temperature difference. Also, these can be flexible, thus facilitating the incorporation in wearable devices.

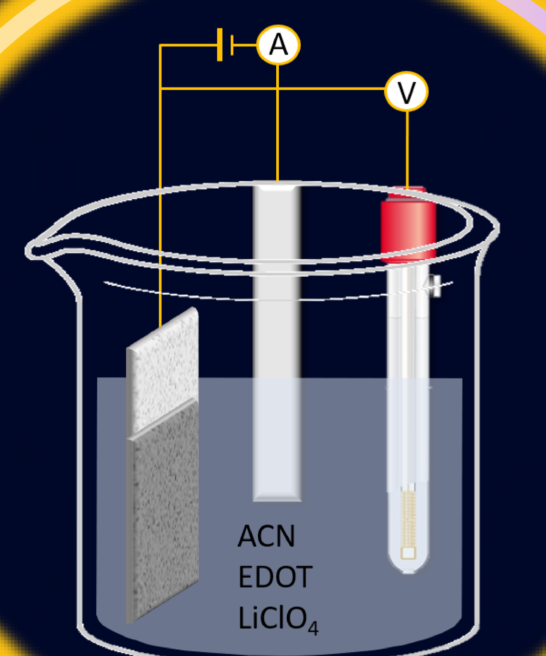
In this work, three methodologies are proposed to obtain flexible thermoelectric materials based on conductive polymers.

2. Synthetic Strategy

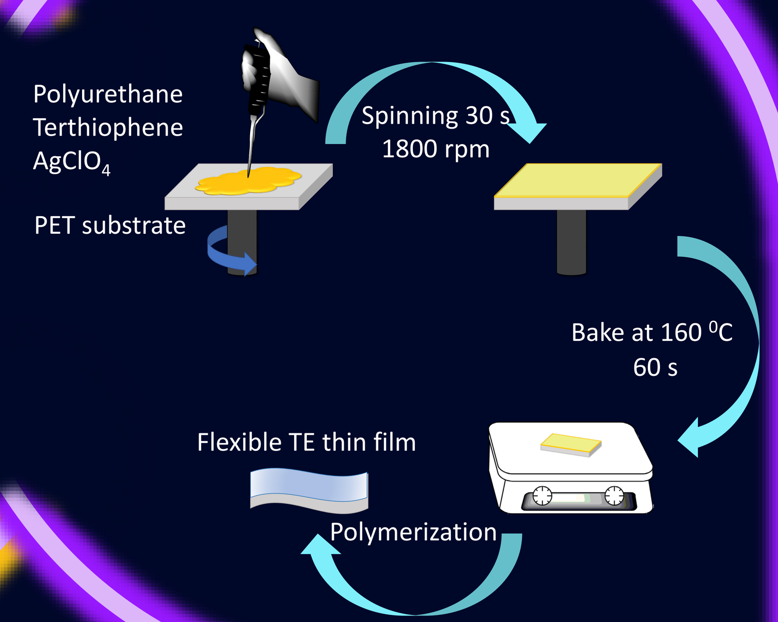
2.1 Layer-by-Layer assembly on PET substrate



2.2 Electrochemical deposition on fabrics



2.3 In-situ polymerization in a flexible matrix



3. Results and Discussion

3.1 Layer-by-Layer assembly on PET substrate

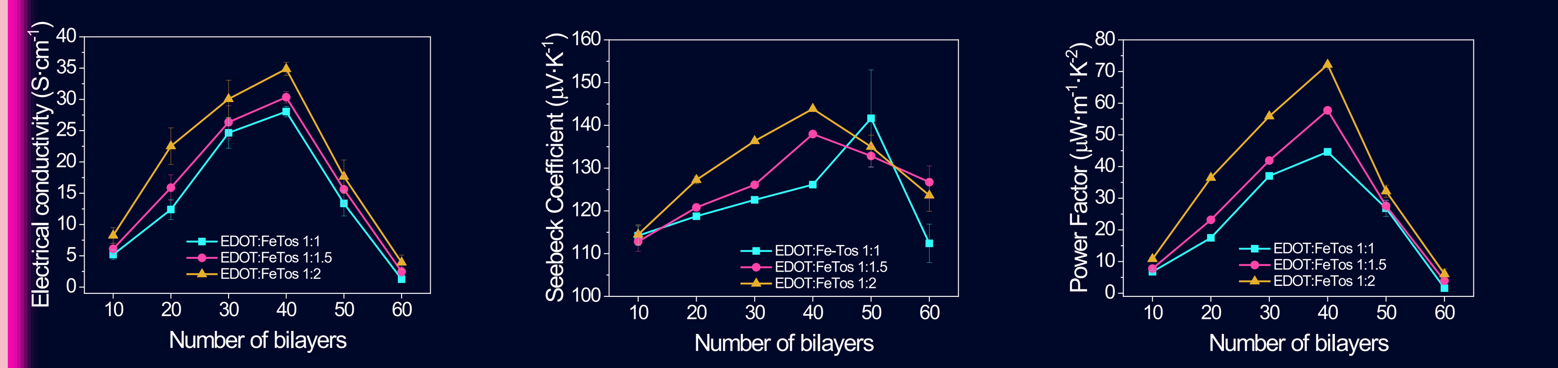


Figure 1. Thermoelectric measurements as a function of the number of bilayers (BL) PEDOT:SWCNT with different molar ratios EDOT:Fe-Tos.

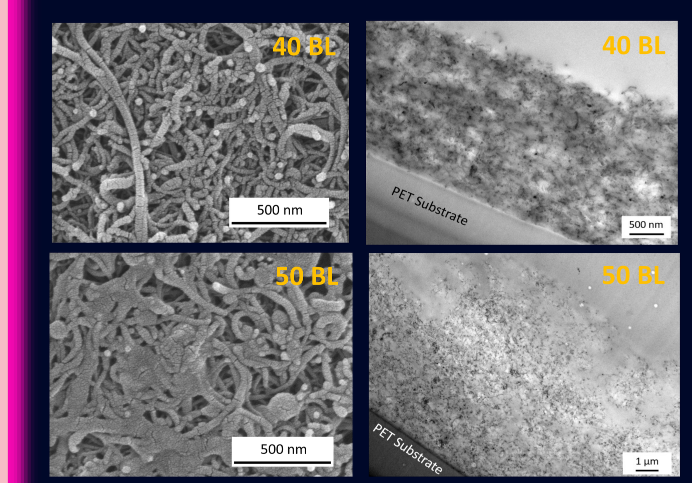


Figure 2. SEM and TEM cross-section of the films with 40 BL and 50 BL.

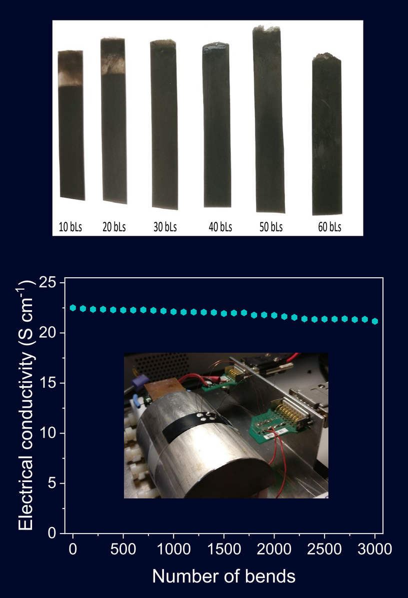


Figure 3. Real image of the films obtained and the flexibility test of the film.

3.2 Electrochemical deposition on fabrics

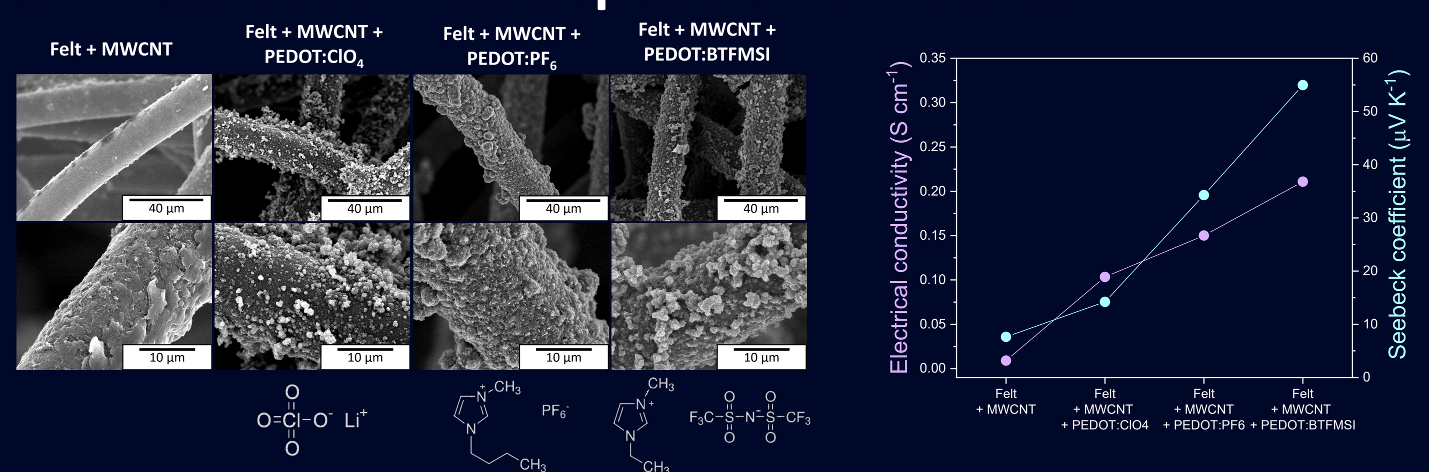


Figure 4. SEM images and thermoelectric performance of felt fabrics coated with MWCNT and PEDOT with different counter-ions.

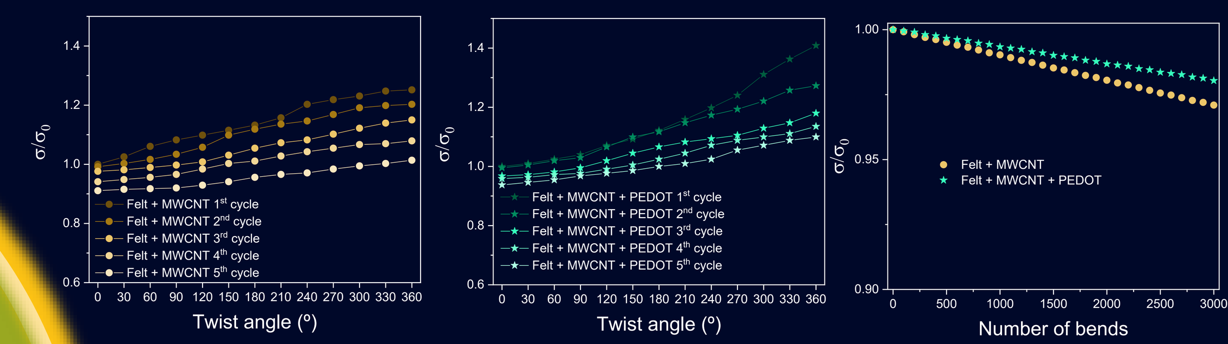


Figure 5. Torsion and bending tests to check the flexibility of the fabrics obtained.

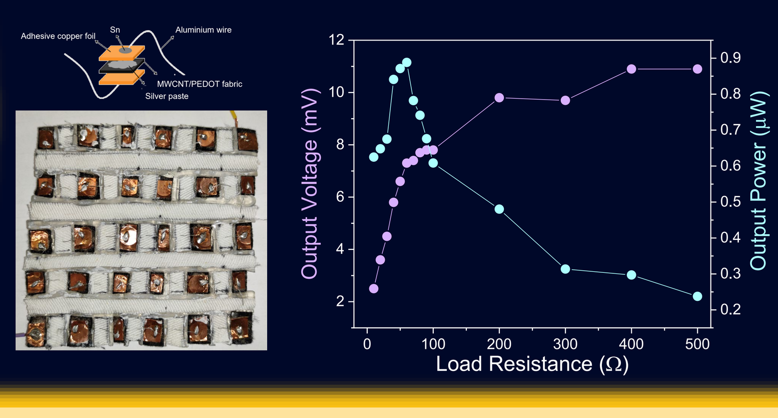


Figure 6. Thermoelectric module based on the fabric obtained and its performance.

3.3 In-situ polymerization in a flexible matrix

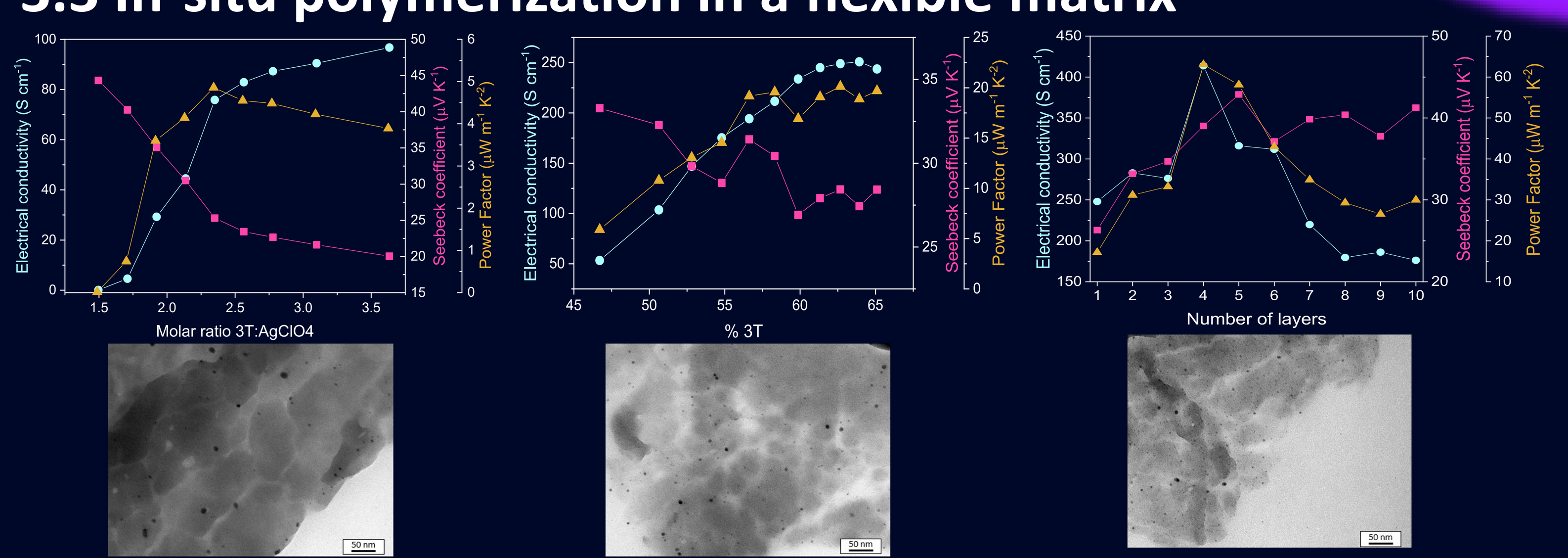


Figure 7. Enhancing the Power Factor by optimizing the molar ratio 3T:AgClO$_4$, the amount of 3T, and the number of layers. TEM images of the films obtained, where can be observed silver nanoparticles.

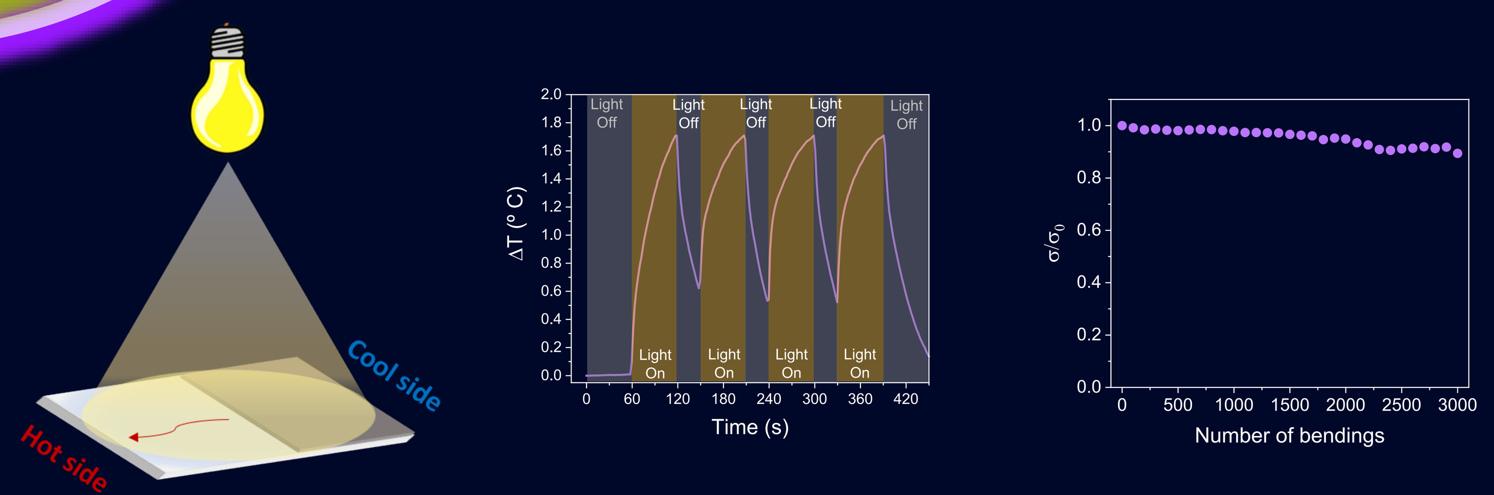


Figure 8. Study of the thermoplasmonic effect due to the presence of silver nanoparticles in the film and the flexibility test of that film.

4. Conclusion

- The three methodologies allow us to obtain flexible thermoelectric materials.
- The development of fabric-based thermoelectric generators allows us to get closer to smart clothing and generate energy from body heat.
- The introduction of a conductive polymer within a thermoplastic matrix allows us to obtain high flexibility. Furthermore, the presence of plasmonic silver nanoparticles allows us to generate a temperature difference with sunlight.

5. References

1. Serrano-Claumarchirant et al. *Coatings* **2020**, *10*, 22
2. Serrano-Claumarchirant et al. *ACS Appl. Mater. Interfaces* **2020**

6. Acknowledgement

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