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A Systematic Investigation of Microstructure, Thermal Stability, Conductivity, and Solubility in Polyaniline Doped with Oxalic Acid

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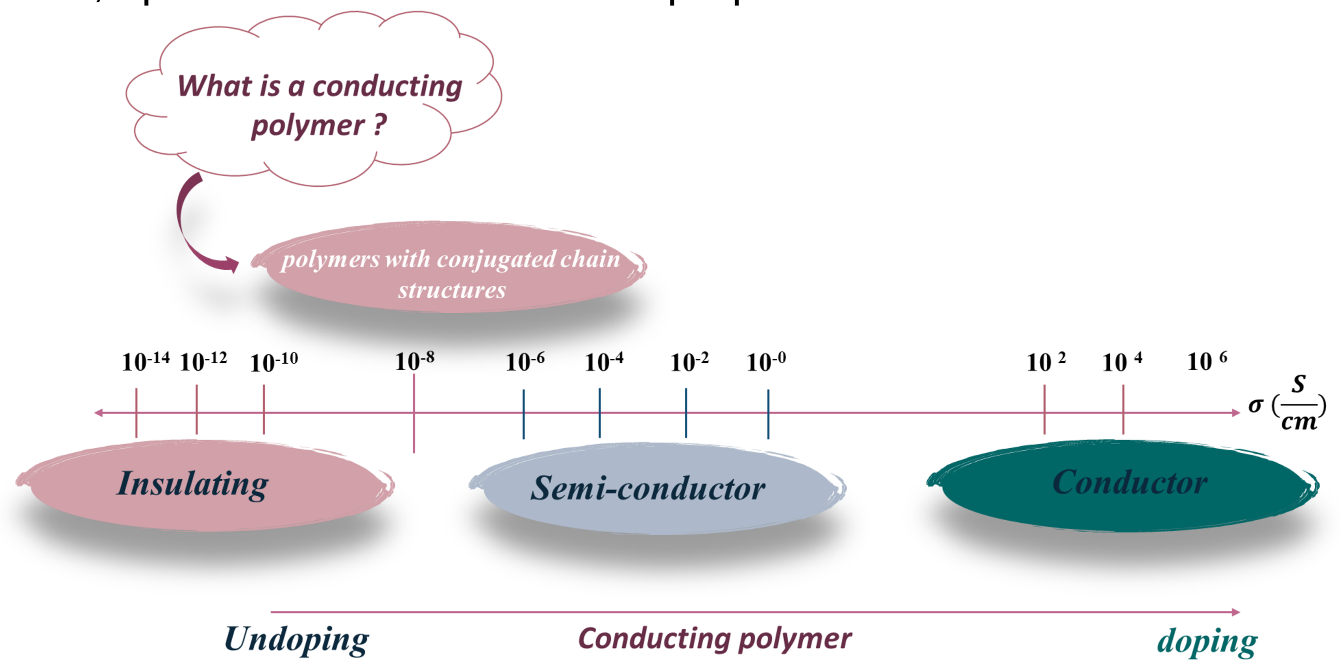
INTRODUCTION & AIM

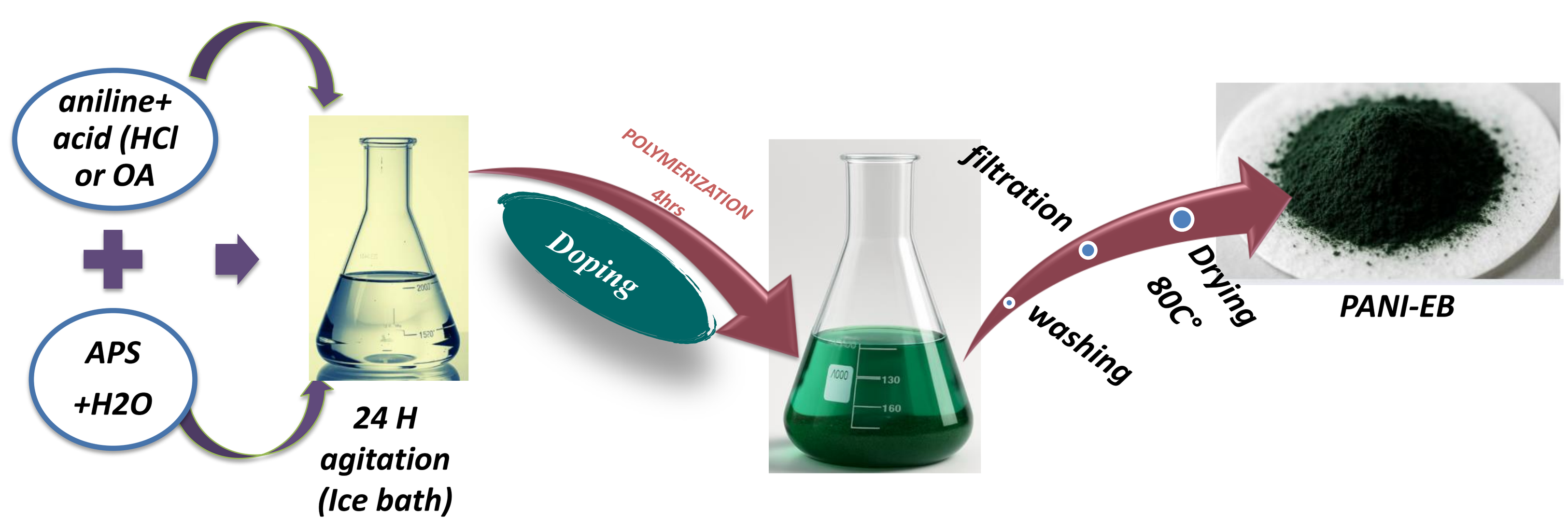
- Currently, conductive polymers allow the development of many sofisticated devices (OLEDs, solar cells, and ultra-sensitive sensors). Polyaniline (PANI) continues to elicit a lot of interest because of its stability, ease of preparation and interesting electrical, optical and electrochemical properties.

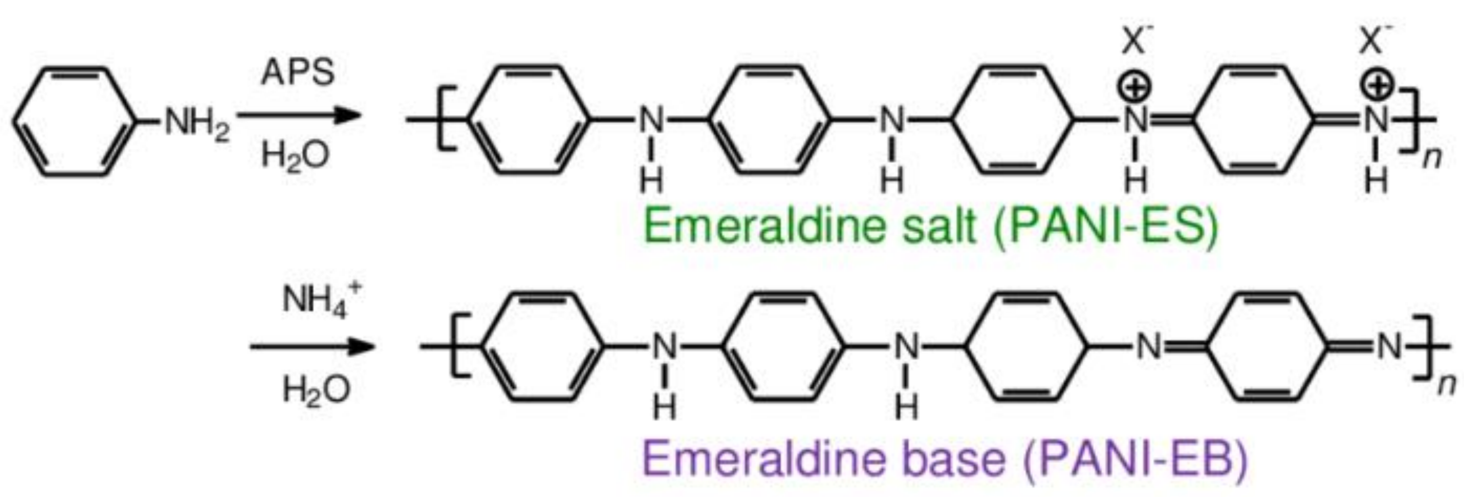


- The most famous is PANI doped with HCl but its applications are often limited by the the corrosive effect of the mineral acid and its insolubility in water and several solvents. This study investigates the use of oxalic acid, a safer organic acid, as a functional dopant to create an environmentally benign and more processable form of PANI.
- Oxalic acid is soluble in most solvent, it has antioxidant activities, antibacterial and antiviral activity.

METHOD

1. Polyaniline synthesis





2. Materials characterization

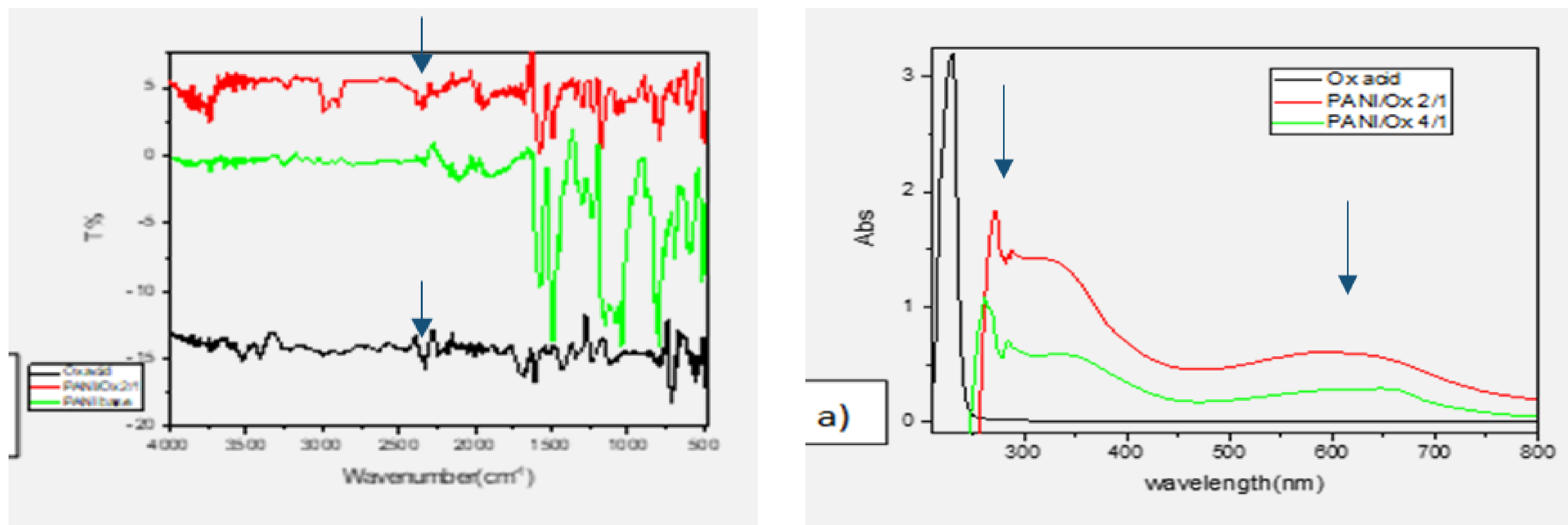
PANI/HCl

PANI/OA

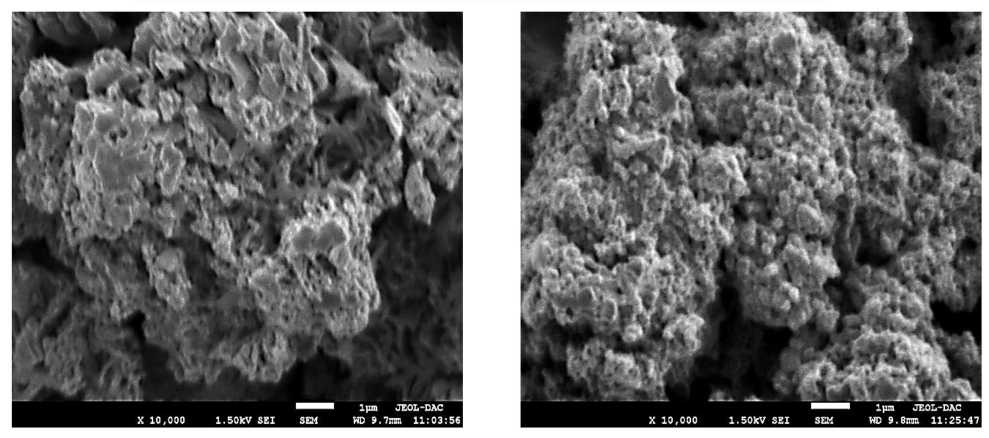
- FTIR
- UV-Vis
- SEM
- TGA
- Four point probe Conductivity
- Solubility

RESULTS & DISCUSSION

Structural characterization



Morphological characterization



Conductivity and Solubility

	PANI/HCL	PANI/OX	
PANI	-	4/1	2/1
Conductivity (mS/cm)	0.177	0.126	0.163

FTIR analysis confirmed the successful doping of PANI with oxalic acid, evidenced by significant shifts in the benzenoid and quinoid ring stretching vibrations and an enhanced band at ~1158 cm^{-1}, indicating charge delocalization. Furthermore, SEM imaging revealed a significant morphological transformation from a classic "cauliflower-like" structure in PANI-HCl to an ordered "rod-like" microstructure in PANI-OA.

This structural change was accompanied by a trade-off in performance where PANI-OA exhibited lower electrical conductivity (1.23 S/cm) and reduced thermal stability compared to PANI-HCl (329 S/cm).

However, these drawbacks were offset by a critical gain in processability, as PANI-OA demonstrated excellent solubility in polar aprotic solvents, whereas PANI-HCl remained intractable.

CONCLUSION

Doping polyaniline with oxalic acid sacrifices conductivity and thermal stability for major gains in processability, safety, and morphological control. This work validates the use of functional organic dopants to engineer task-specific conductive polymers with tailored properties for solution-based fabrication.

FTIR and UV-Vis spectroscopy, Scanning Electron Microscopy (SEM), Thermogravimetric Analysis (TGA), four-point probe conductivity measurements, and qualitative solubility tests.