Electrically conductive Polypyrrole films to produce biomimetic systems

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Introduction

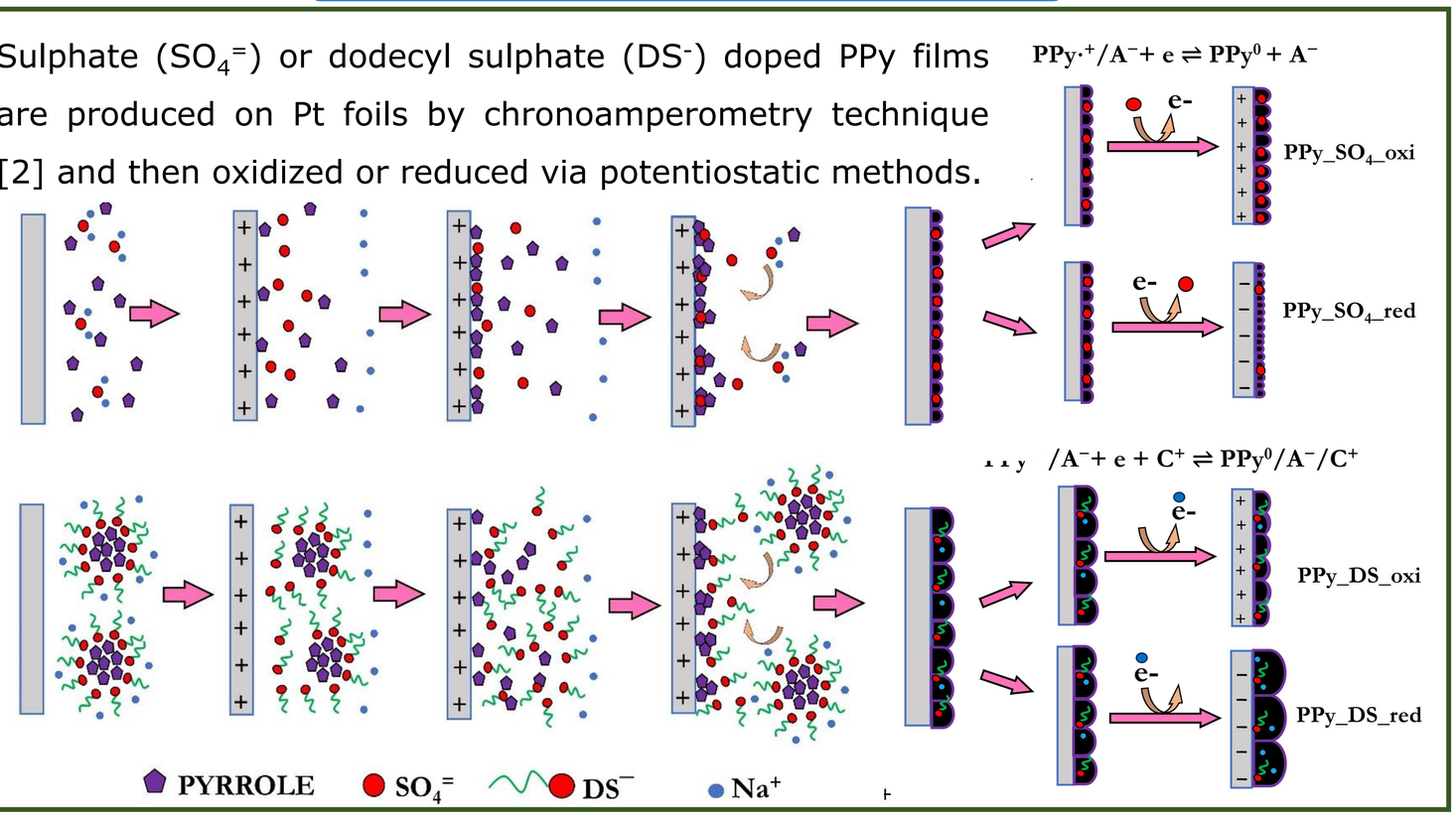
The properties of biocompatibility, electroactivity in physiological environments and conformational movements upon redox processes make polypyrrole (PPy) a promising conducting polymer (CP), to realize biomimetic systems such as bioactuators, biosensors and tissues scaffolds [1,2].

Aim of the work

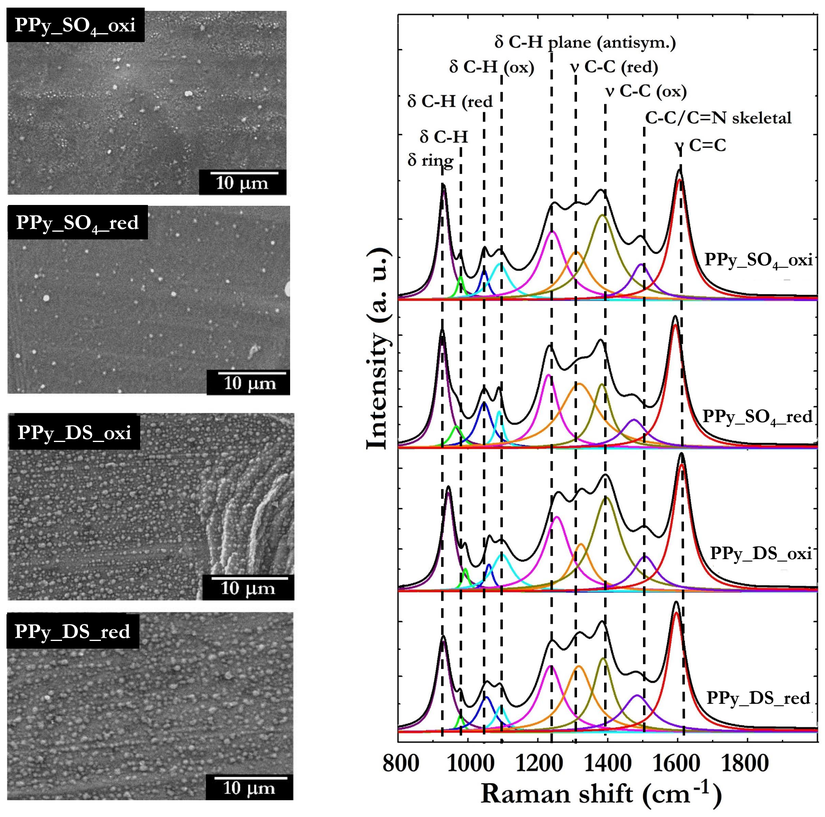
In order to exploit doped-PPy films as biomimetic systems, the topographical, structural, and conformational changes induced by redox processes on PPy chains are investigated as a function of the dopant agents' nature.

Experimental

Sulphate ($SO_4^=$) or dodecyl sulphate (DS^-) doped PPy films are produced on Pt foils by chronoamperometry technique [2] and then oxidized or reduced via potentiostatic methods.

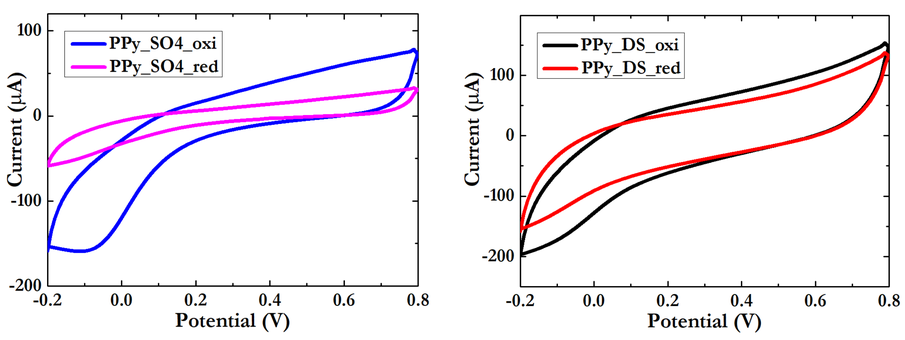


SEM and Raman Spectroscopy Characterizations



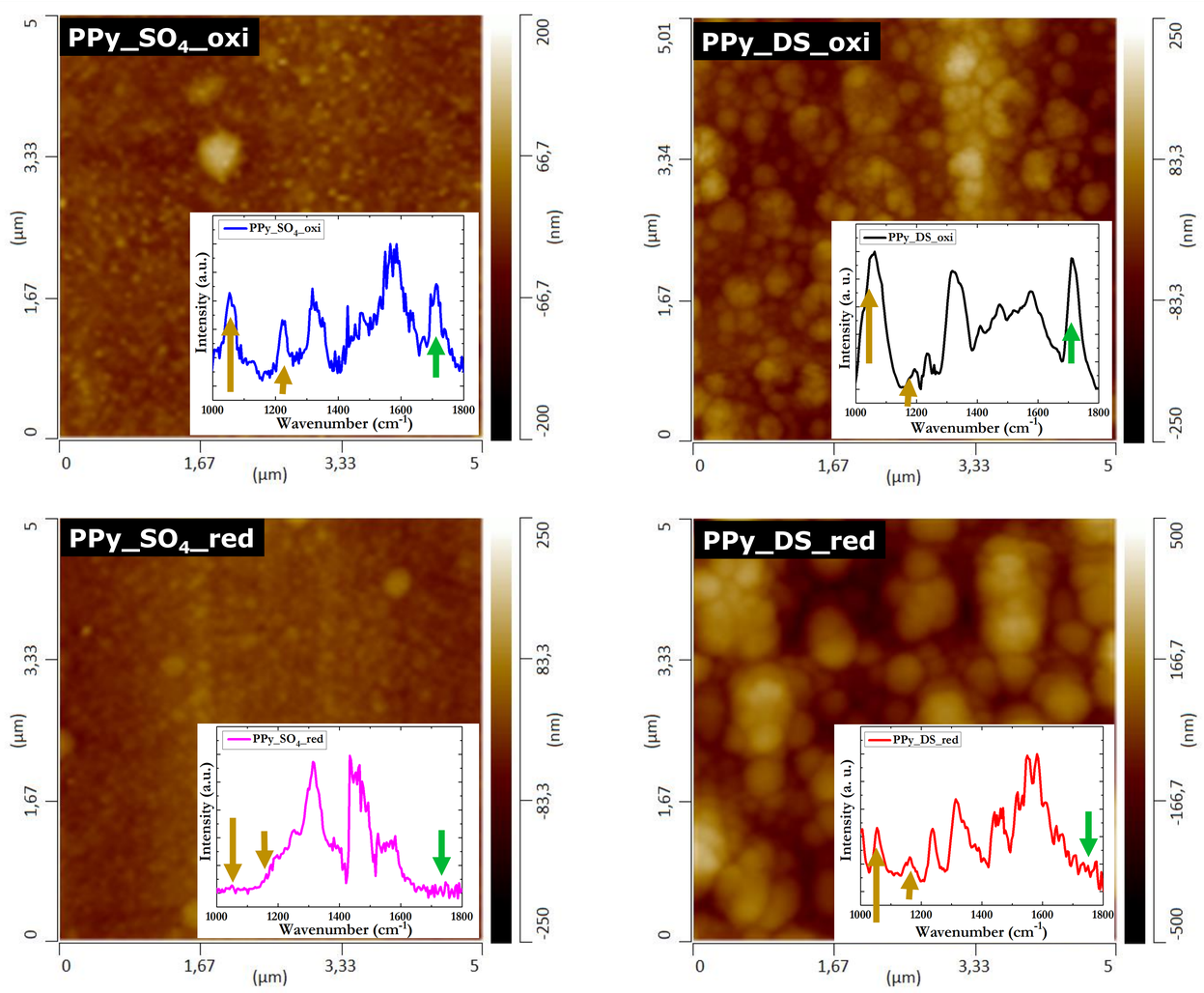
The presence of $SO_4^=$ or DS^- dopant agent strongly influences the morphology of the polymeric films. Raman spectra showed the typical features of PPy. Independently on the dopant, the percentage of oxidized PPy chains is estimated around 40 and 70% for reduced and oxidized PPy films, respectively.

Ciclic Voltammetry



The voltammetric curves of PPy_SO4 and PPy-DS show different profiles, due to the dependence of the redox pathway on the nature of the dopant anion.

AFM-assisted Tip-enhanced IR Nanospectroscopy



The AFM images show that the presence of $SO_4^=$ or DS^- dopant agent induces an opposite swelling/deswelling behavior in PPy films, confirming that the nature of the dopant counterion is crucial to redox processes.

The shape, the intensity, and the position of the bands in the IR spectra suggest the movement of the ions between the polymer and the solution depending on the different applied potential.

Conclusions

The feasibility to modulate the conformational movements of the polymeric films during the redox processes as a function of the dopant agent makes doped-PPy films promising candidates as biomimetic materials for bioactuators, tissues scaffolds or biosensors.

References

1. S. Politi, S. Battistoni, R. Carcione, L. Montaina, S. Macis, S. Lupi and E. Tamburri, *PANI-Modified Ti-Doped CVD Diamond As Promising Conductive Platform to Mimic Bioelectricity Functions,* Advanced Materials Interfaces 2021, **8(24)**, 2101401.
2. S. Politi, R. Carcione, E. Tamburri, R. Matassa, T. Lavecchia, M. Angjellari and M. L. Terranova, *Graphene platelets from shungite rock modulate electropolymerization and charge storage mechanisms of soft-template synthetized polypyrrole-based nanocomposites*, Scientific Reports, 2018, **8(1)**, 1-18.