# Conductivity Degradation Study of Polypyrrole and Polypyrrole/5% w/w $TiO_2$ nanocomposite under Heat Treatment in He and Atmospheric Air

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The thermal aging of the d.c. electrical conductivity σ in pure polypyrrole (PPy) and in the nanocomposite PPy/5%w/w $TiO_2$ was investigated for thermal treatment times from 0 to 50 hours at different temperatures T = 100, 300 and 380 K under atmospheric air and inert He gas. In both materials the fluctuation induced tunneling (FIT) of charge carriers was followed revealing a granular metal structure.

The isothermal variation of σ with time under atmospheric air and inert He indicates the coexistence of two antagonistic mechanisms, the one increasing and the other decreasing σ, as it is shown in Fig.1.

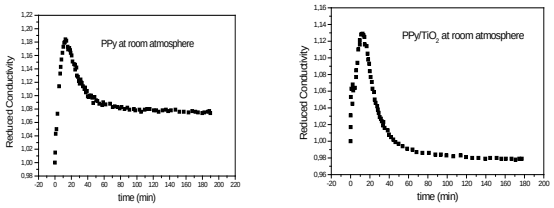



Fig.1. The reduced conductivity of pure PPy and PPy/$TiO_2$ at 300 K under room atmosphere for times from 0 to 200 min.

In XRD patterns from PPy and PPy/5%w/w $TiO_2$ (Fig.2), the sharp peaks of $TiO_2$ coexist with the broad peak of amorphous PPy, which shifts to smaller angles with the addition of $TiO_2$ revealing a greater departure between pyrrole rings, which turns up to be about equal to the diameter of $O^{2-}$ indicating the diffuse of oxygen from $TiO_2$ into PPy.

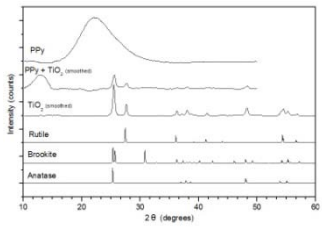
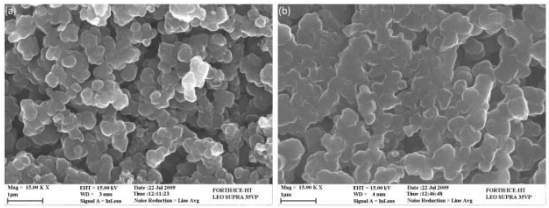



Fig.2 XRD spectrograms from pure PPy, PPy+5%w/w$TiO_2$ and $TiO_2$.

In the SEM pictures, shown in Fig.3., the decrease of the more light regions and the smoothing of the surface with aging confirm the removal of $Cl^-$ and the rearrangement of the




SEM pictures from pristine PPy on the left and thermally aged polymer at 380 K for 36 h on the right.

polymer chains, two antagonistic mechanisms the first decreasing, the second increasing conductivity.