



# ANALYSIS OF THE STRUCTURAL EVOLUTION OF GRAPHENE-CNT-POLYPYRROLE NANOCOMPOSITE.

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**ABSTRACT:** The following work reports the evolution of the formation of polypyrrole (PPy) chains and its intercalation with graphene-carbon nanotubes (G-CNT) nanocomposites. Experiments were carried out to demonstrate the growth of pyrrole through polymerization and its interaction with G-CNT using Cyclic Voltammetry (CV) for 5 – 50 cycles. The interface analysis of the nanocomposite was carried out through SEM. The G-CNT-PPy nanocomposite has shown potential to be used as a supercapacitor which can be further substantiated by CV experiments.

## INTRODUCTION

Structural evolution of various polymers is significantly related to the synthesis and performance of nanocomposite substrates. Polypyrrole is a conductive polymer whose structure is well studied and its role in synthesizing free standing graphene films is crucial. This G-CNT-PPy hybrid nanocomposite can be used as a supercapacitor, which was also previously mentioned by *Ashish et.al*

## MATERIALS AND METHODS

0.89 ml of pyrrole monomer was dispersed in 25 ml of deionized water containing 0.355 g of sodium sulphate. 0.0125 g of CNT and 0.0125 g of graphene was then added to the solution. The solution was further sonicated for 15 minutes at a constant temperature. Cyclic Voltammetry (CV) was used for the synthesis of the nanocomposite film on a graphite rod at a scan rate of 10mV/s in the voltage range of 800 mV – 900 mV. The procedure was repeated for 5, 10, 25, 50 and 100 cycles. Scanning electron microscopy (SEM) and transmission electron microscopy (TEM) were utilized to image the evolving morphology of the G/CNT/PPy nanocomposite. X-ray diffraction (XRD) was utilized to determine the crystal structure and size of the nanocomposite film.

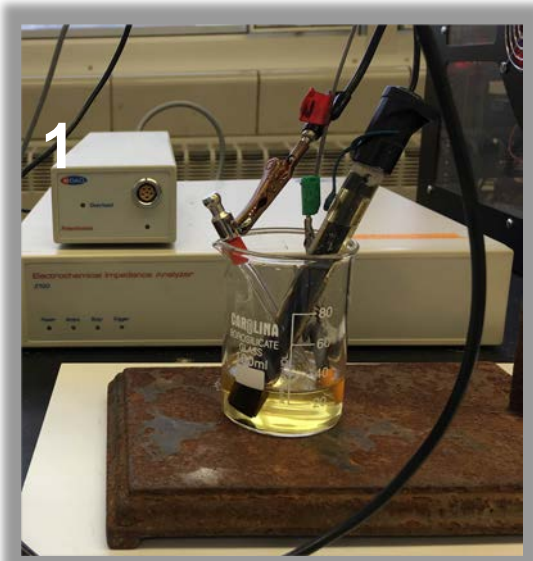


Figure 1 (Left): Cyclic Voltammetry (CV) set-up.

## RESULTS

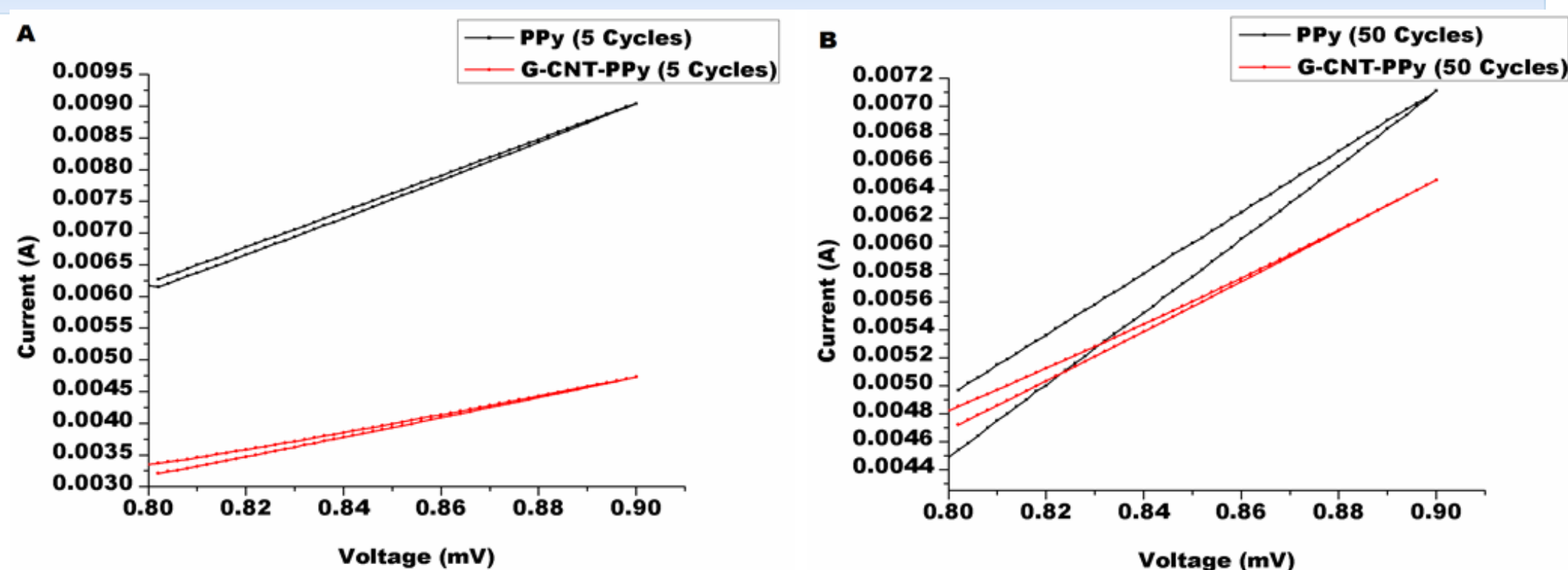


Figure 2: A: CV analysis of 5 cycles; Figure B: CV analysis of 50 cycles

Through CV, it can be hypothesized that with the increase in the number of cycles, the capacitance of Ppy increases pointing to an increase in the polymerization of pyrrole (Fig 2). The current through the

nanocomposite increases with increasing cycles implying the intercalation of G-CNT in polymerizing Ppy that results in the formation of the interface that can be seen from the SEM analysis.

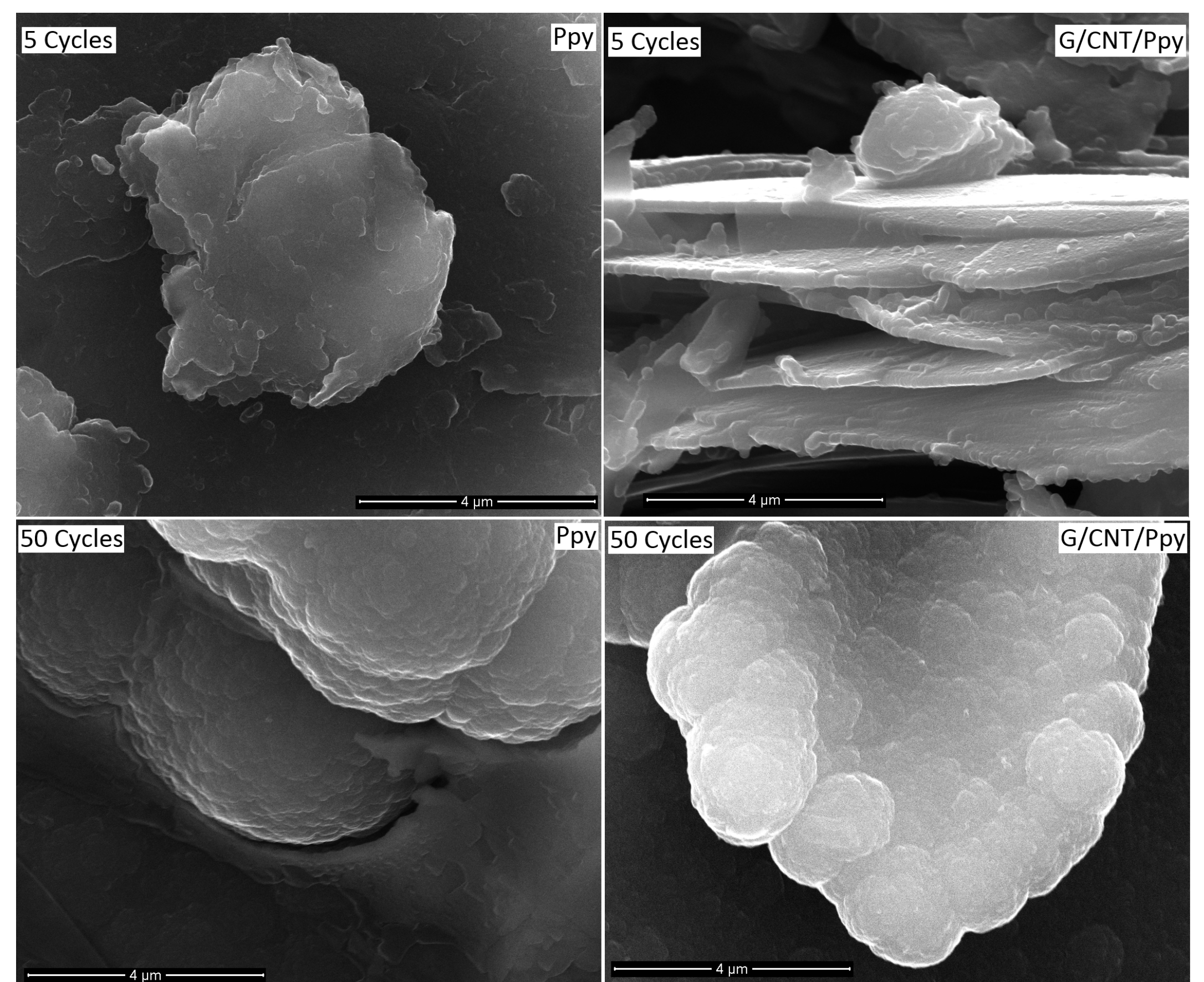


Figure 3: A and B (5 cycles) – Ppy and G-CNT-PPy nanocomposite; C and D (50 cycles) – Ppy and G-CNT-PPy nanocomposite

Compared to 5 cycles, 50 cycles shows a densely polymerized Ppy as also indicated by the CV data. Comparing Ppy and G/CNT/Ppy for 5 cycles, the interface evolution of G-CNT-Ppy can be clearly observed. Furthermore, a multiple layered structure can be seen in 5 cycles G/CNT/Ppy image showing lesser quantity of Ppy compared to the 50 cycles image, where Ppy is covering the entire graphenated assembly. Also, from figure 2, with an increase in the number of cycles, the capacitive charge storage capability of the nanocomposite is seen to be increasing.

## CONCLUSION

The elucidation of the structural evolution of G/CNT/Ppy is a good start in bringing a new biocompatible nanocomposite material to the forefront whose complete study can improve the performance of the devices such as a supercapacitors by modulating its charging and discharging characteristics as well as its apparent use in biosensing for medical diagnostics.

## REFERENCES