Metal octacarboxyphthalocyanines on multiwalled carbon nanotubes for dye solar cells application: Synthesis and characterisation

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TUT Student Seminar 2011, Arcadia campus

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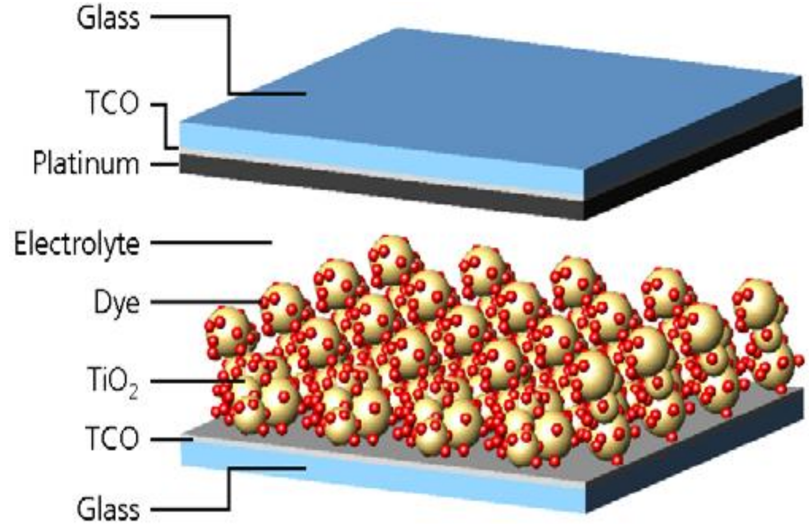
Outline

- Background and Introduction
- Synthesis
- Characterization
- Electrochemical Evaluation
- Conclusion and future work
- Acknowledgements

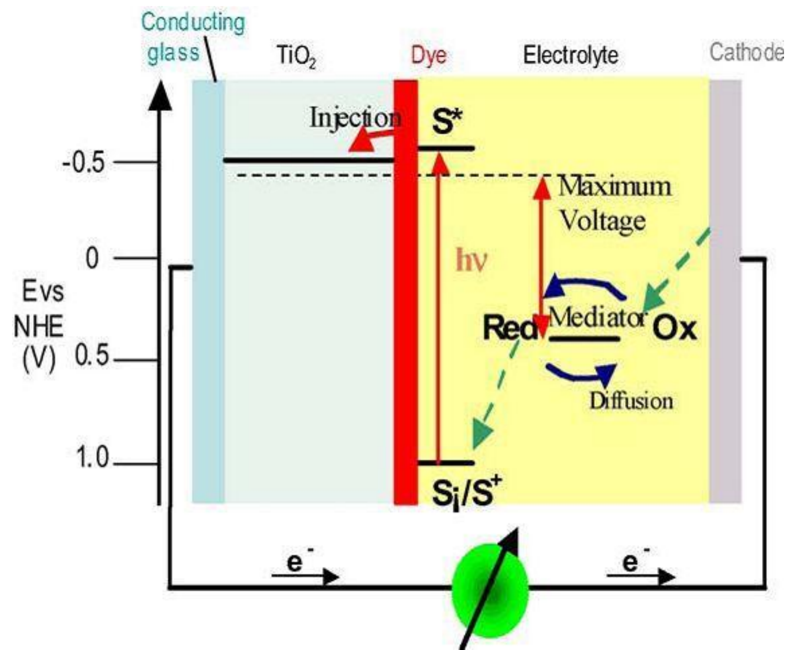
What is Dye solar cells (DSC)?

- Low cost
- Easy to fabricate
- Non toxic
- Light weight and semitransparent

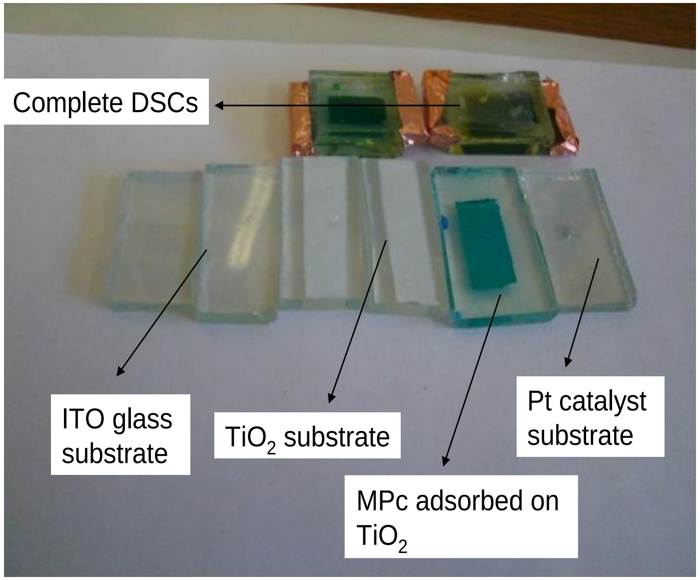


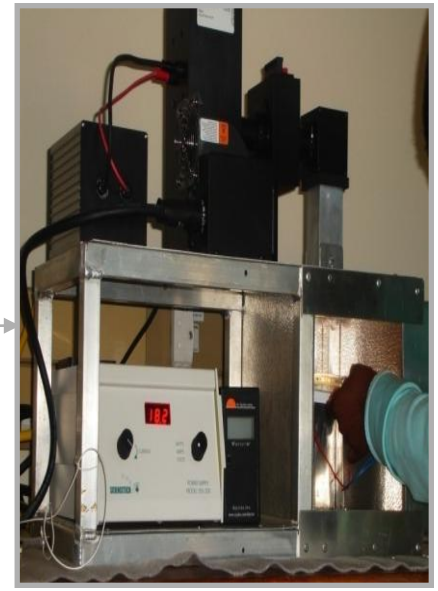
First reported in 1991, by O'Regan and Gratzel with a solar power conversion of 11%.

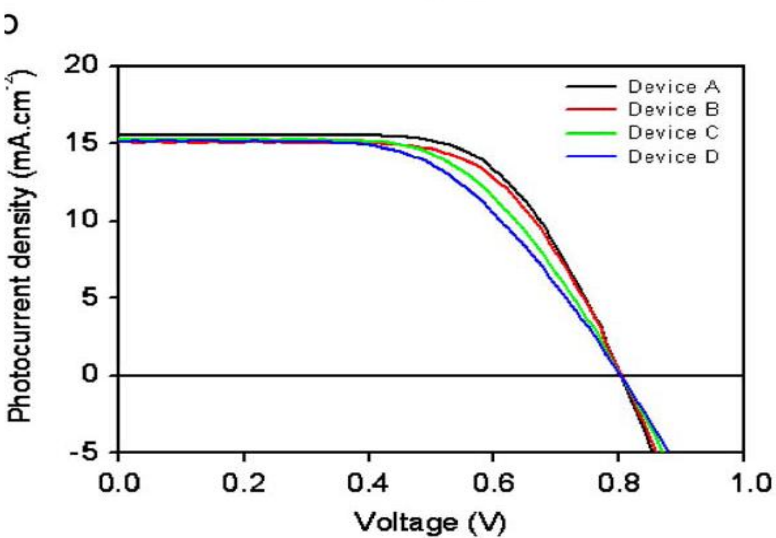
3 main components : Working electrode, Counter electrode and Electrolyte (iodide/triiodide redox couple)



Manufacturing and testing of DSCs







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Major research areas

• Investigate an alternative photosensitiser

enhance the performance and efficiency of DSC.

Requirements for Sensitisers

• Sensitisers should be panchromatic

• Contain functional groups such as Carboxylic group

• It should have suitable ground and excited state for redox properties

• The energy level of the excited dye molecule should be well matched to the lower bound of the conduction band

• Stable to sustain about 10^8 turnover cycles for about 20 years when exposed to light

• Thermal and photochemical stability

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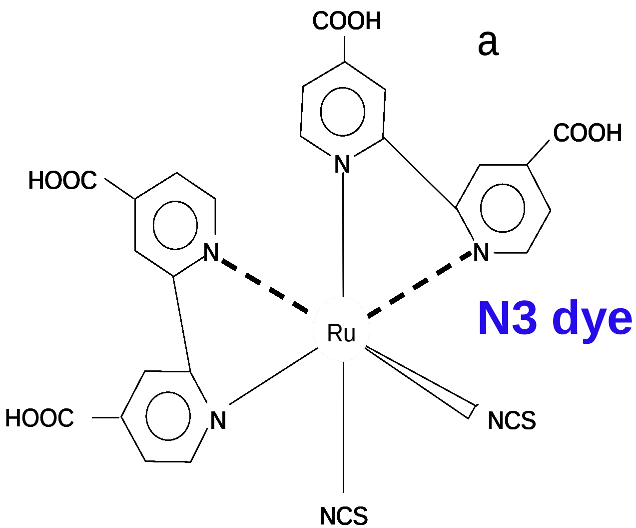
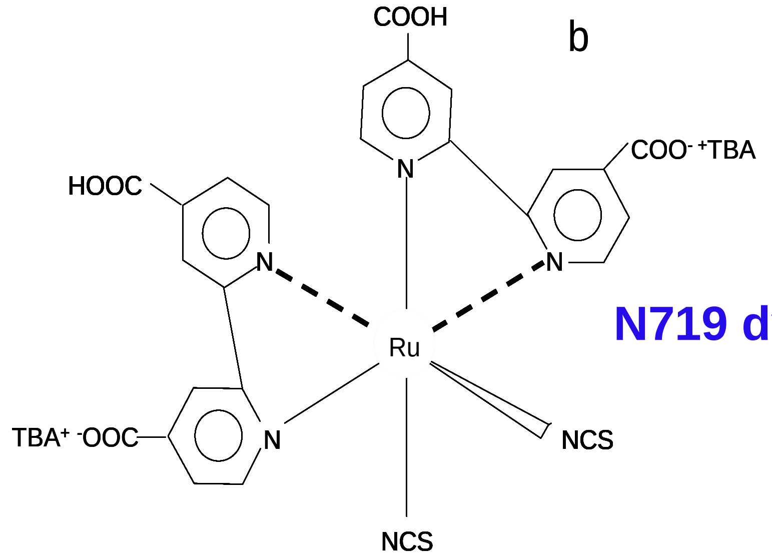
Alternative photosensitiser

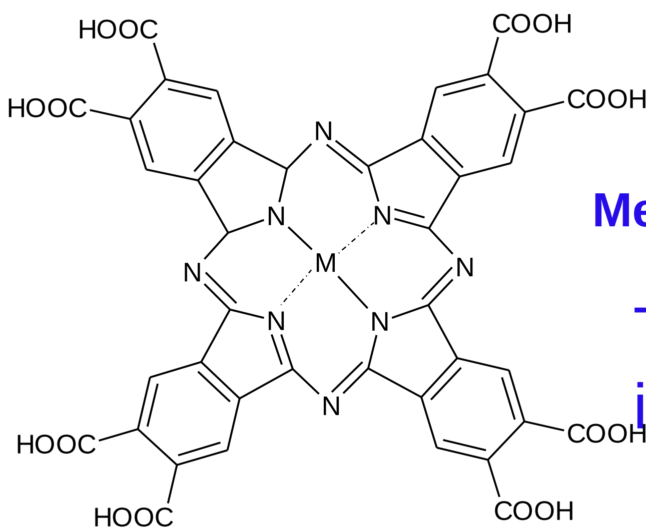
- Main components – light driven process



N3 dye



N719 dye



Metal octacarboxyphthalocyanines

The use of MPC in DSCs is rarely reported

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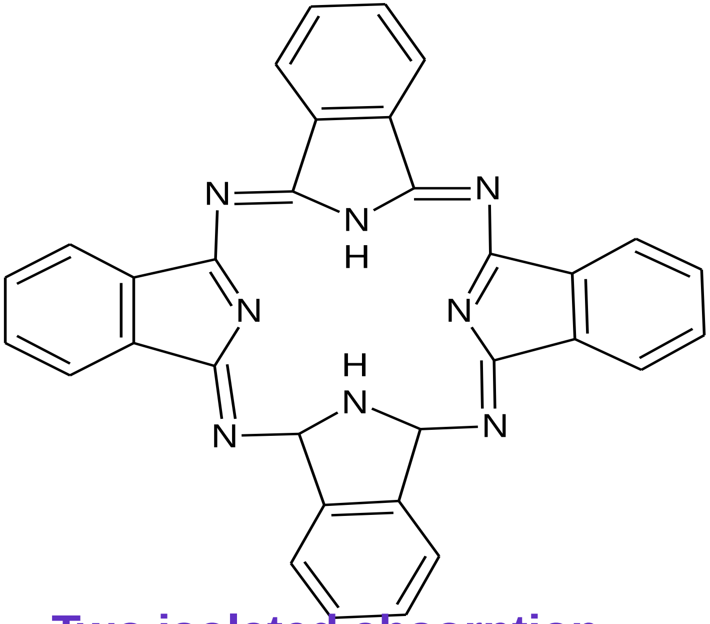
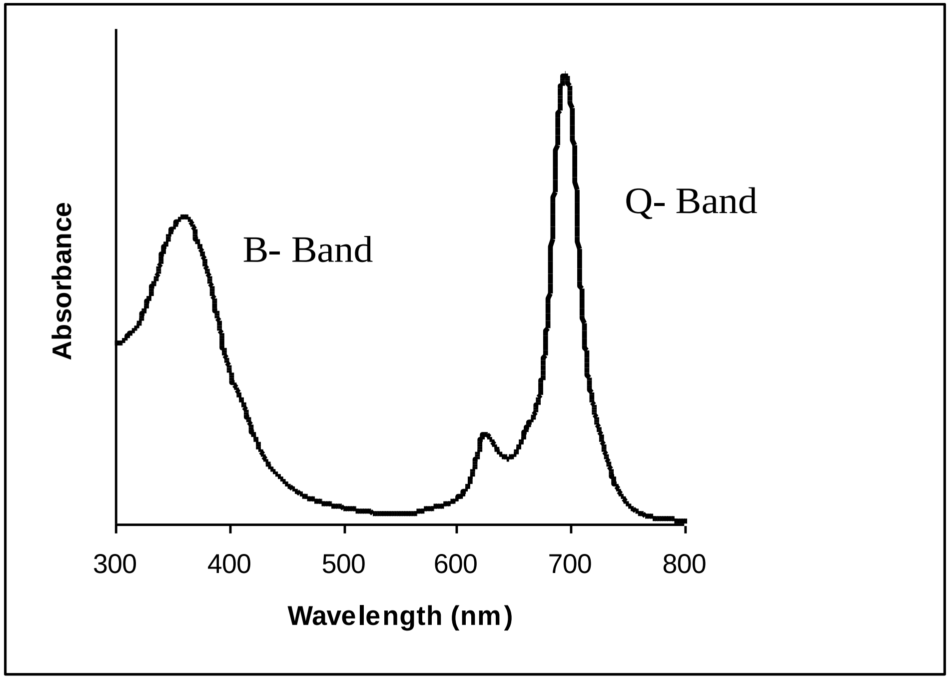
Background of Phthalocyanines

- •Aromatic planar complex
- •Tetraazoporphyrins – four isondole unit
- •Braun and Teherniac – 1907
- •Pigments and dyestuff





- •Two isolated absorption band
- •Water soluble MOCPC – soluble in DMF and NaOH
- •Modifying MPC with MWCNT
- •CNT – efficient catalyst and conductive species

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Approach:

- Synthesise various metal octa carboxy phthalocyanine (M = Ga, Zn, Si);
- Modification with multiwalled carbon nanotubes;
- investigate the spectroscopic, microscopic;
- determine the electrochemical behaviour of metal octacarboxy phthalocyanines supported on carbon nanotubes
- Incorporate in DSC

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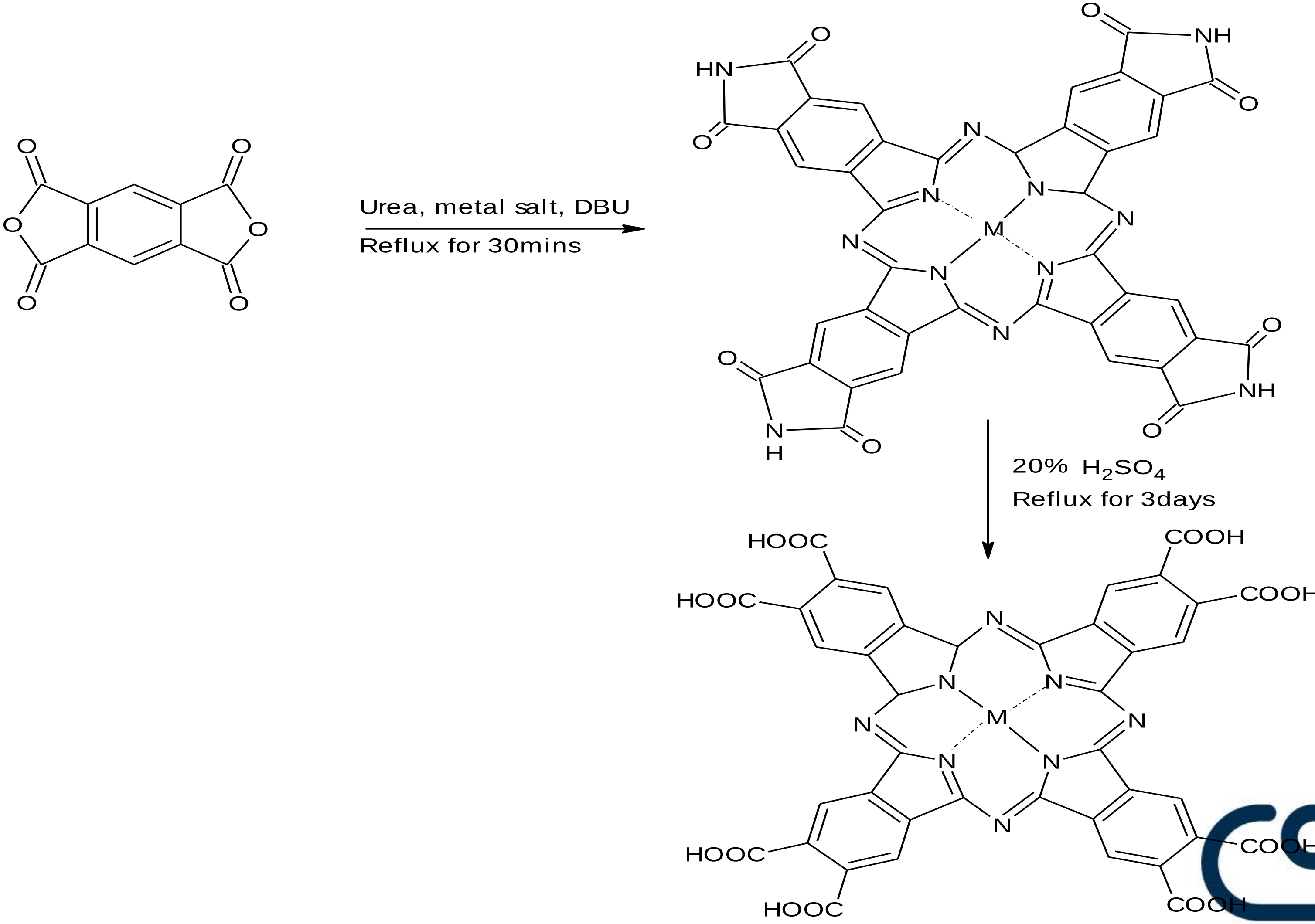
Synthesis of Metal Octacarboxyphthalocyanines



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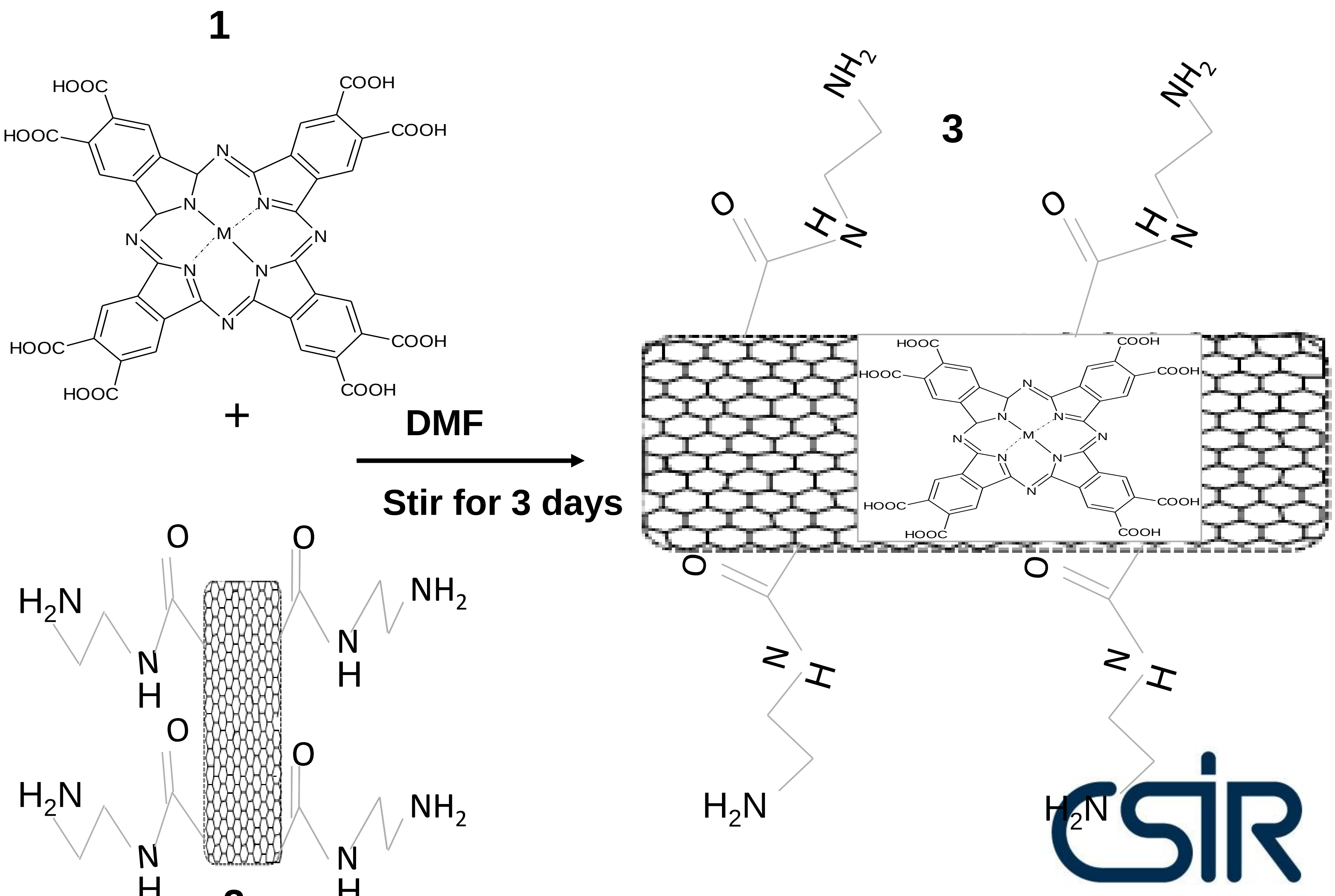

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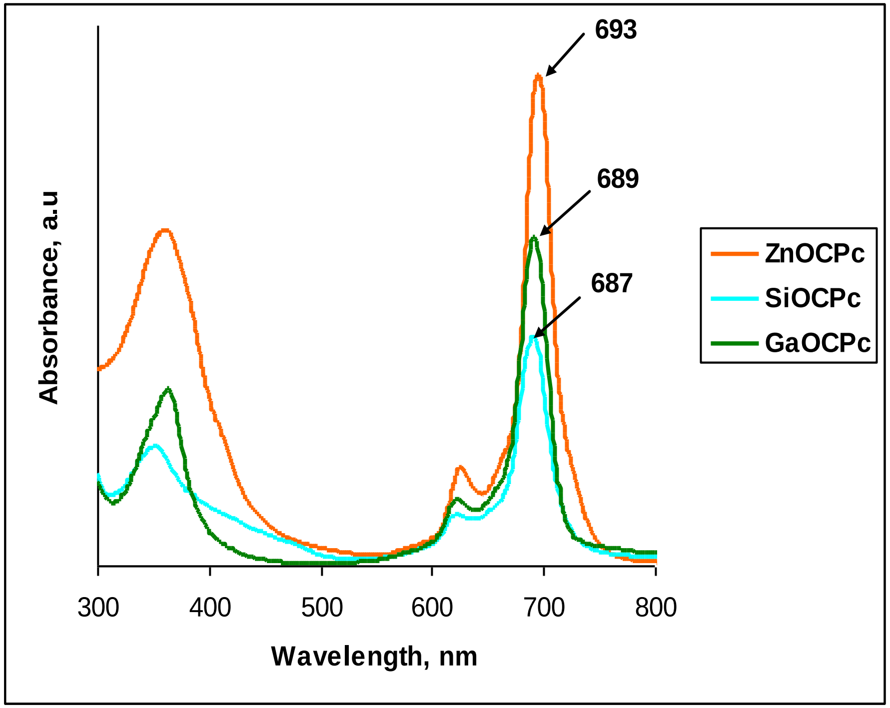
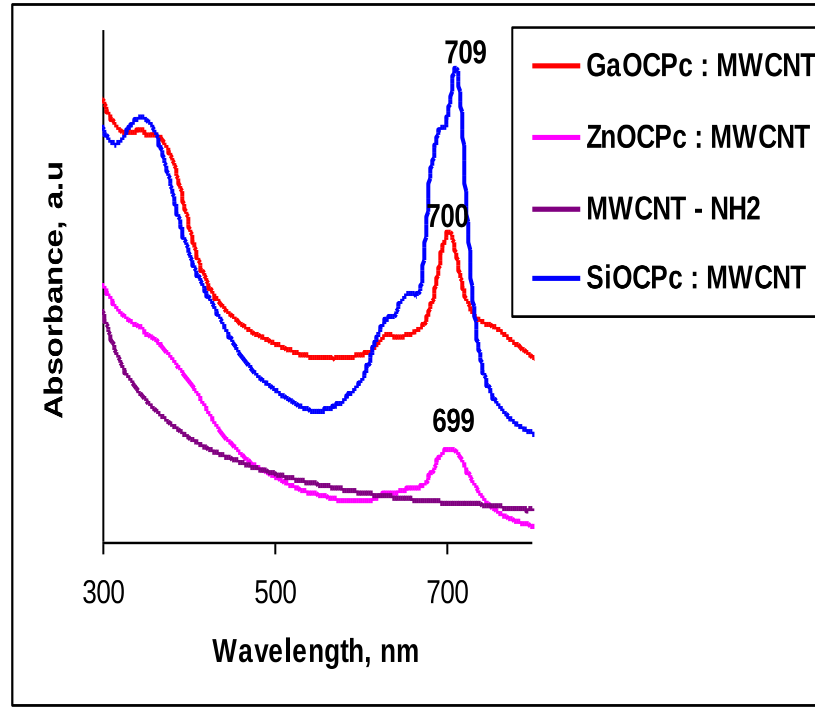
Spectroscopic evaluation

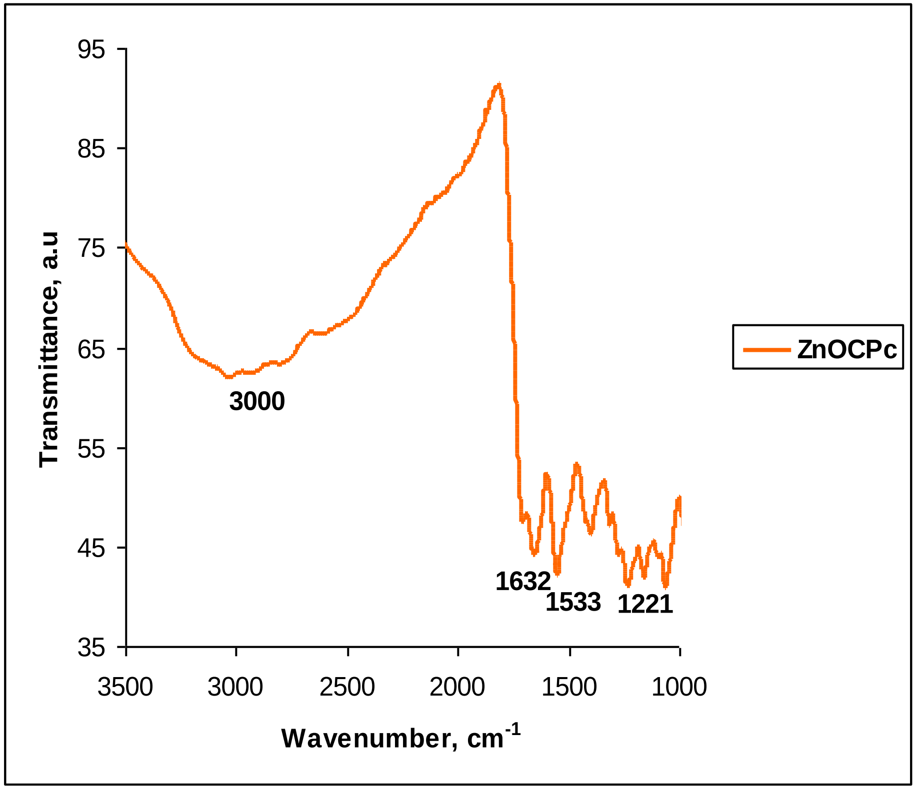


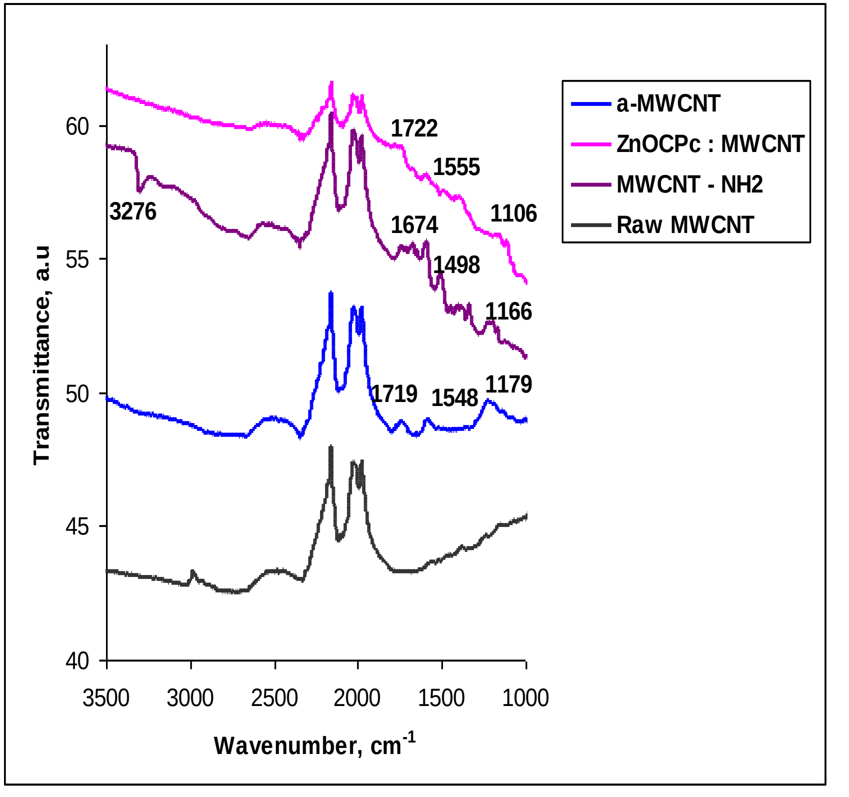


UV/Vis spectra of
1. ZnOCPc 2. SiOCPc 3. GaOCPc in DMF

UV/Vis spectra of 1. ZnOCPc : MWCNT 2. SiOCPc : MWCNT 3. GaOCPc : MWCNT
4. MWCNT – NH_2 in DMF

FTIR Results





FTIR of ZnOCPc

FTIR spectra of Raw MWCNT, a-MWCNT, MWCNT – NH_2 and ZnOCPc : MWCNT

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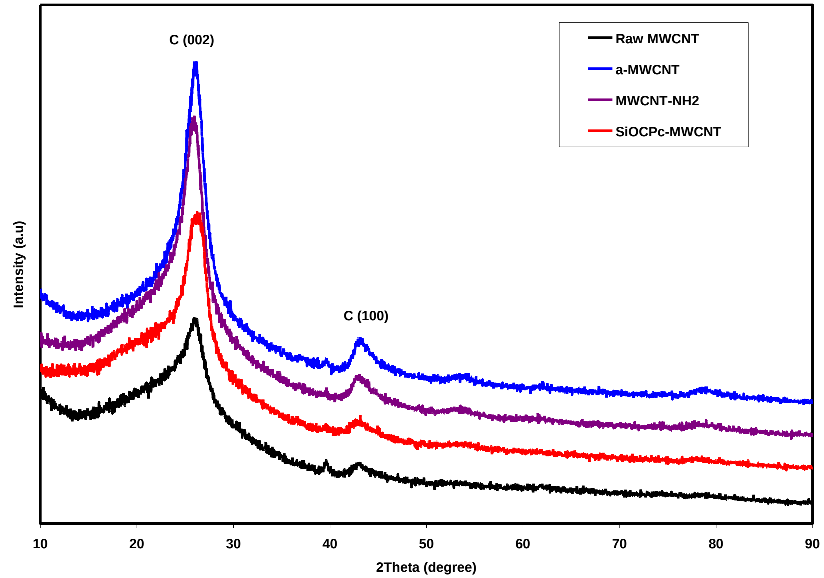
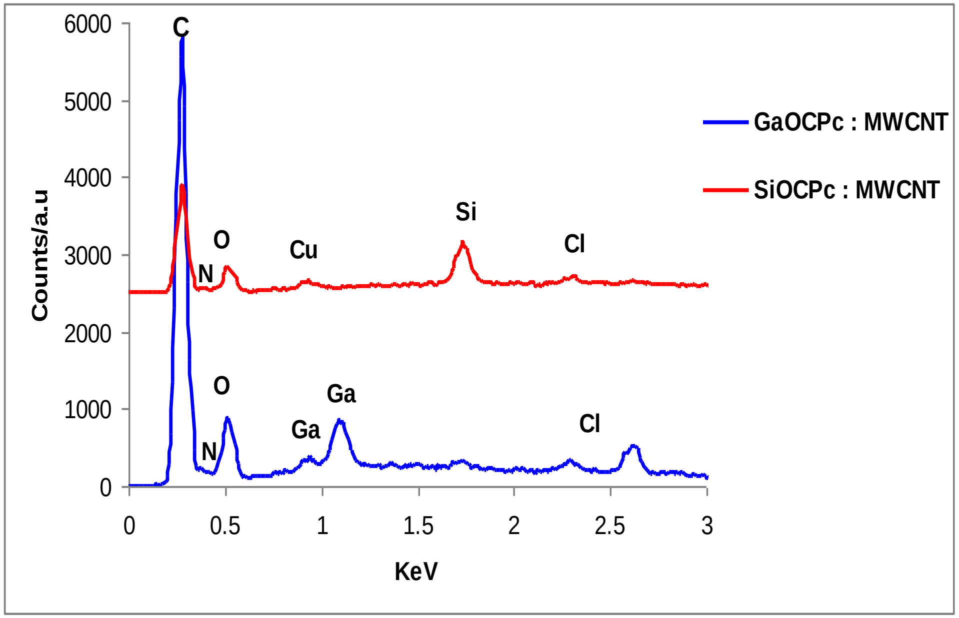
Results



XRD patterns of Raw MWCNT,
a – MWCNT, MWCNT – NH2 and
SiOCPc :MWCNT



EDX profile of GaOCPc : MWCNT and SiOCPc : MWCNT

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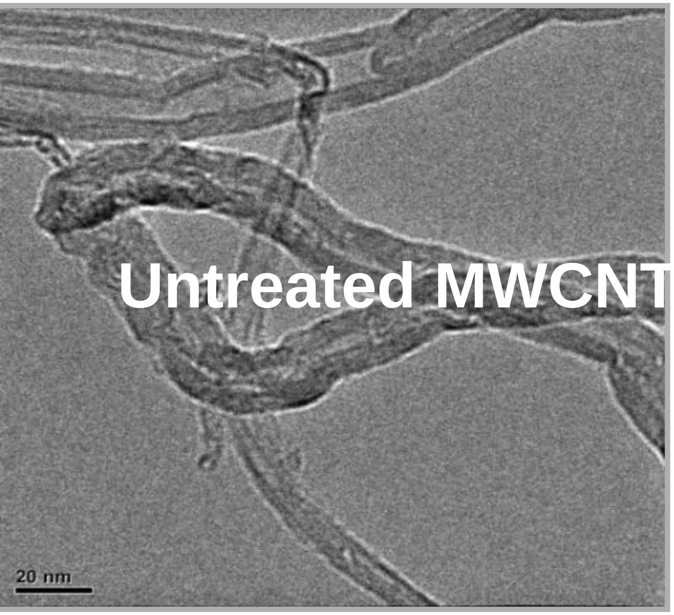
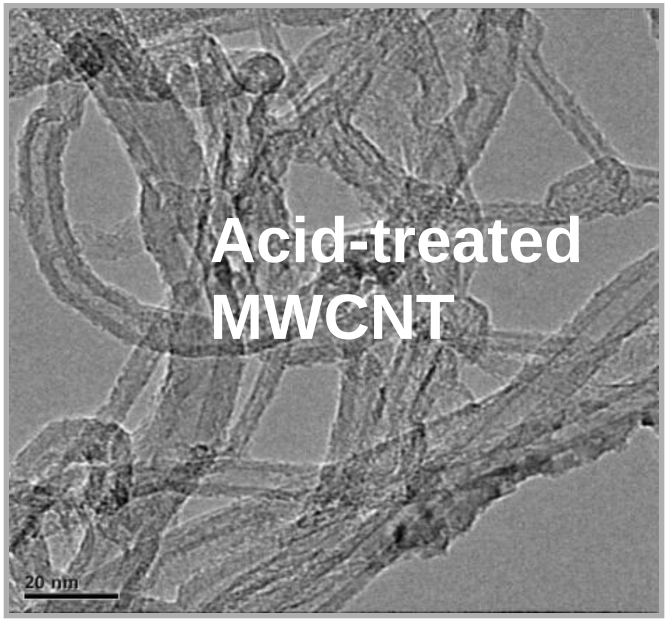
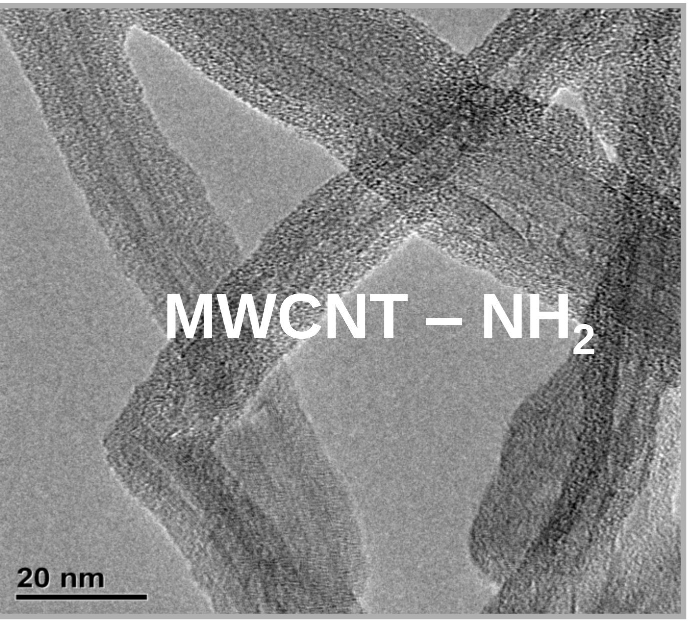
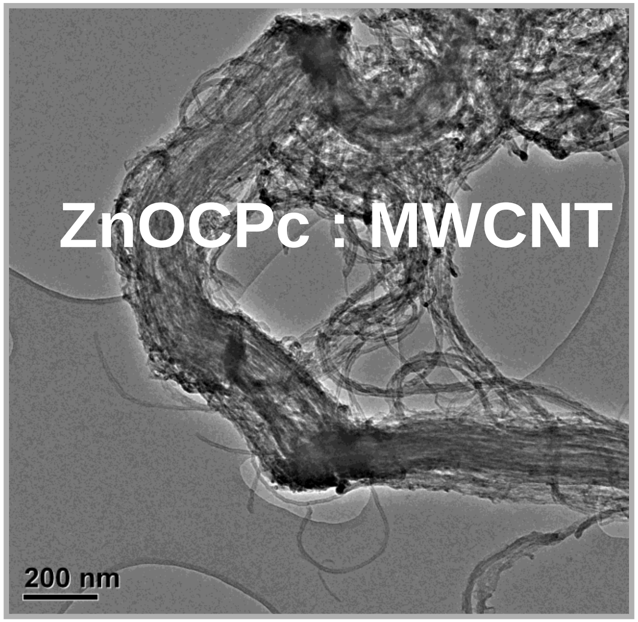
TEM





- Figures show MWCNTs after each stage of the functionalisation step
- Increase in the metallic content noticed (dark spots





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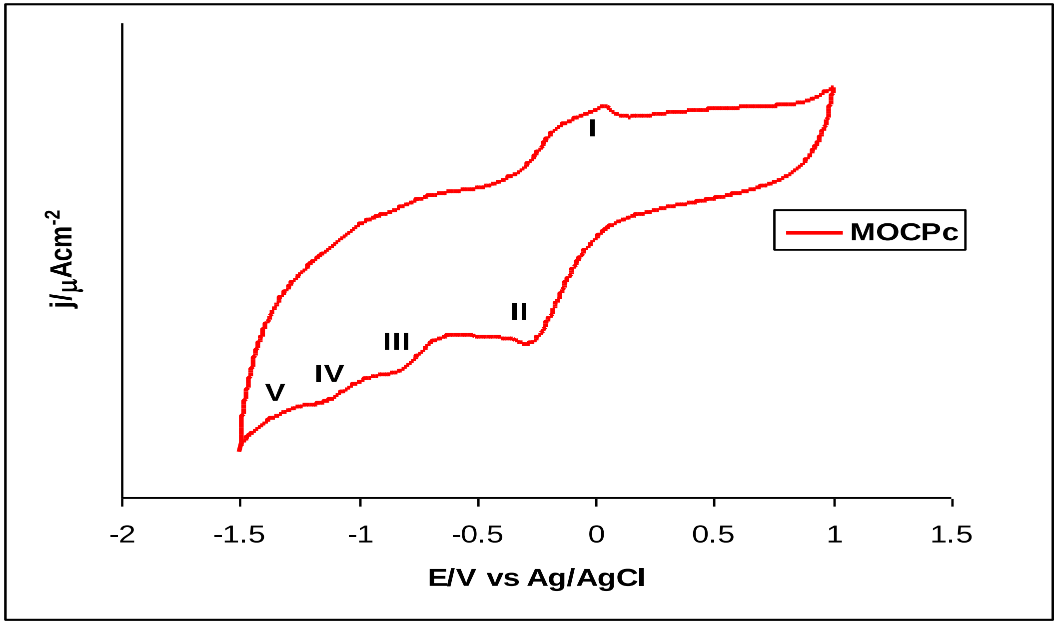
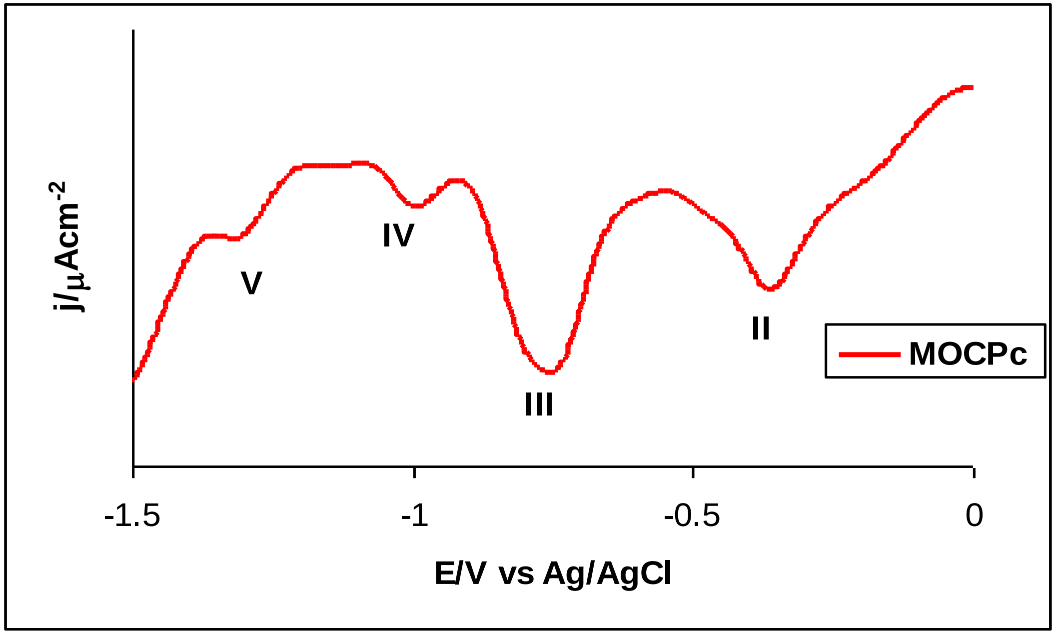
Eletcrochemical evaluation





- Four anodic peak and one cathodic peak
- Associated for MPC ring

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Conclusions

- MOCPc (M = Ga, Si, Zn) complexes and their carbon nanotubes composites were successfully synthesised and satisfactorily characterised using FTIR, UV/Vis and electrochemistry.

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Thank You

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