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

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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

Complete DSCs

ITO glass substrate

TiO₂ substrate

Pt catalyst substrate

MPc adsorbed on TiO₂

Photocurrent density (mA cm⁻²)

Voltage (V)

Device A

Device B

Device C

Device D

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our future through science
Major research areas

• Investigate an alternative photosensitiser to 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
**Alternative photosensitiser**

- Main components – light driven process

![Chemical structures](image)

- **N3 dye**
- **N719 dye**

**Metal octacarboxyphthalocyanines**

The use of MPC in DSCs is rarely reported
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
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
Synthesis of Metal Octacarboxyphthalocyanines

Urea, metal salt, DBU
Reflux for 30 mins

20% H₂SO₄
Reflux for 3 days
Stir for 3 days
UV/Vis spectra of
1. ZnOCPc 2. SiOCPc 3. GaOCPc in DMF

FTIR Results

FTIR of ZnOCPc

FTIR spectra of Raw MWCNT, a-MWCNT, MWCNT – NH$_2$ and ZnOCPc : MWCNT
Results

XRD patterns of Raw MWCNT, \(\alpha\) – MWCNT, MWCNT – NH\(_2\) and SiOCPc : MWCNT

EDX profile of GaOCPc : MWCNT and SiOCPc : MWCNT
TEM

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

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