Synthesis of polyaniline with urea-based carbon dots for pseudocapacitance energy storage

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Introduction

Polyaniline (PANI) is one of the most versatile and utilized conductive polymers in energy storage devices because of its possibility to undergo Faradic reactions, showing pseudocapacitance and ease of synthesis from aniline monomer. However, due to its poor cyclability and capacity retention is necessary to enhance its performance by incorporating additives. [1]

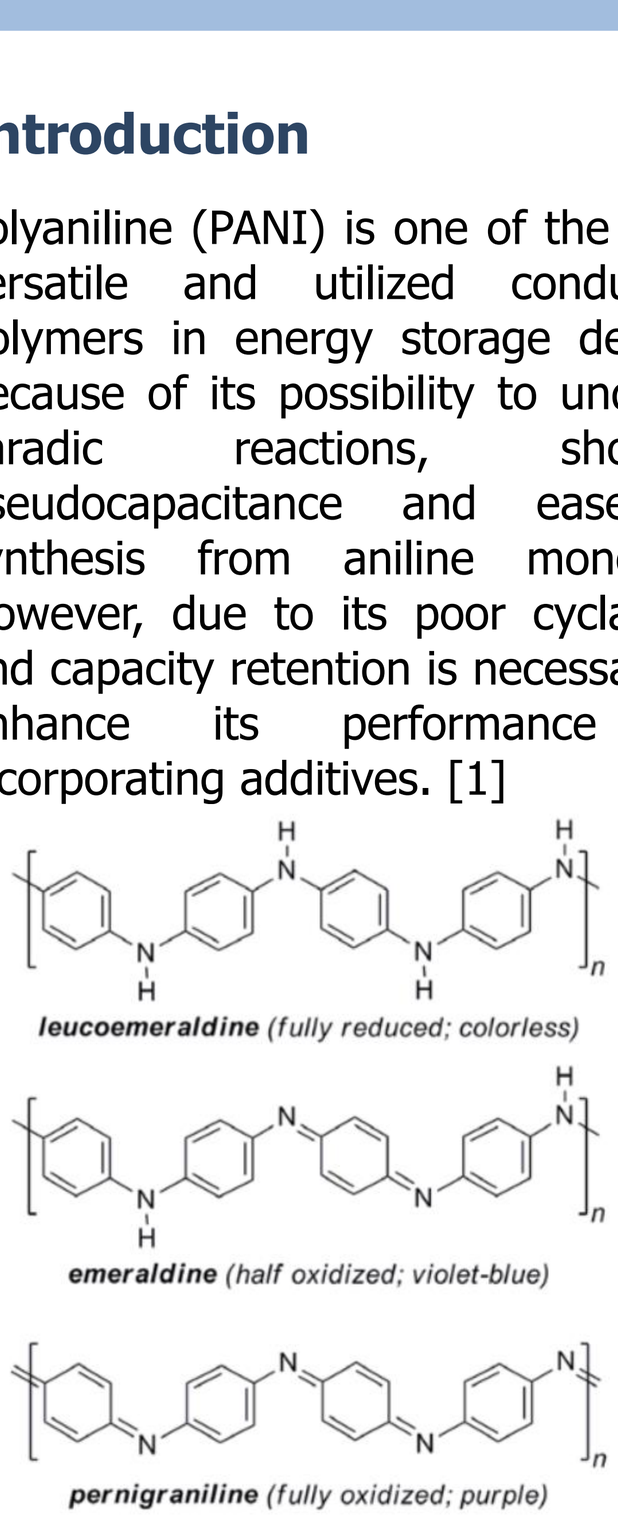

Fig1. Primary oxidation states of polyaniline.

This research delves the novel approach of embedding CDs in-situ polymerization within the PANI matrix. CDs are renowned for their electronic properties and are incorporated in an attempt to augment the capacitance of PANI, and capacity retention.

UV-Vis spectroscopy is employed for band gap analysis, and Fourier-transform infrared spectroscopy (FTIR) for a comprehensive analysis of PANI.

Objective

1. Polymerization of PANI with and without CDs.
2. UV-Vis and FTIR characterizations.
3. In-depth understanding of material properties before and after CDs embedding.

Methods

Two samples were prepared: **PANI** as reference and **PANI_UG-CDs**. A black powder was obtained and stored for analytical characterization.

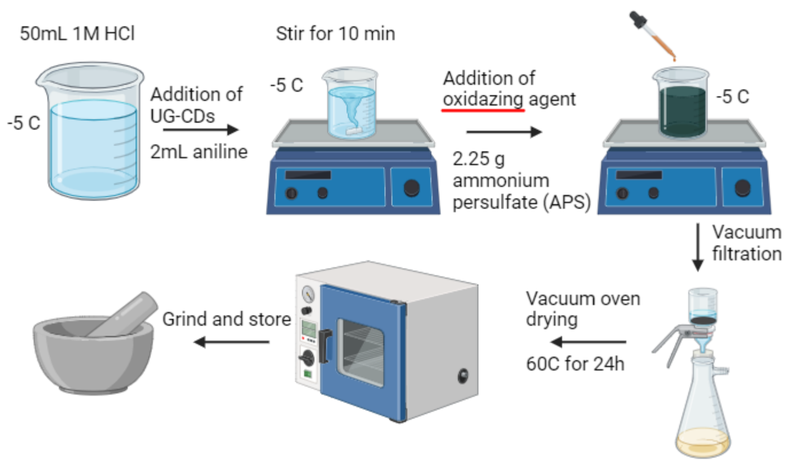

Fig2. In-situ CDs addition during PANI polymerization. [2]

Results

PANI's FTIR and PANI embedded with UG-CDs show very similar peak results, suggesting no significant secondary structure changes is observed from CDs embedding. Observable peaks at 1300-1400cm-1 and peaks 800 cm-1 represent the in and out of plane C-H bending, respectively. The peak at 1480cm-1 reflects C-C stretching vibrations of the benzenoid ring. At 3400cm-1 of UG-CDs, this peak is attributed to the presence of OH groups which maybe from water molecules being absorbed. At 1440cm-1 carboxyl group attributes to the vibrational C-O bond are observed and at 1100cm-1 stretching of the C-O bond[3].

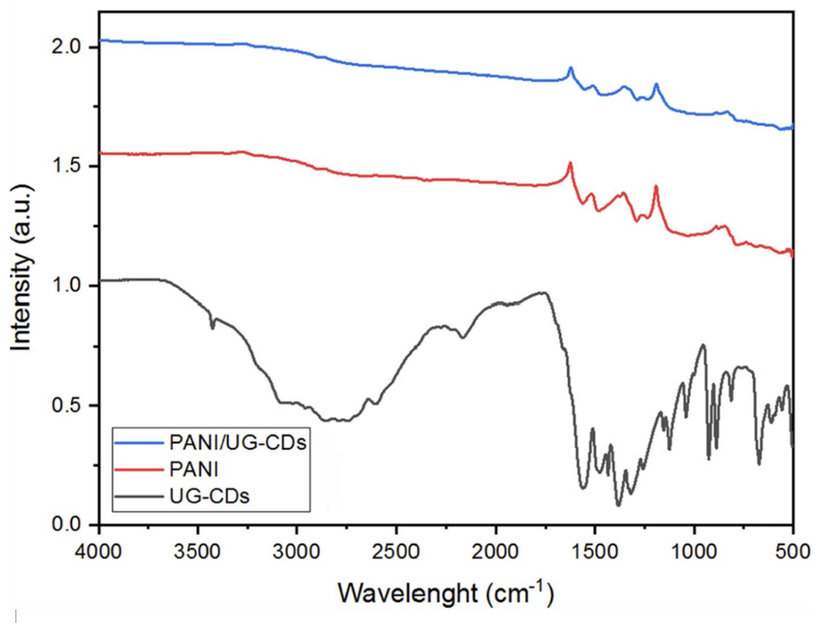

FIG3. FTIR characterization of synthesized materials.

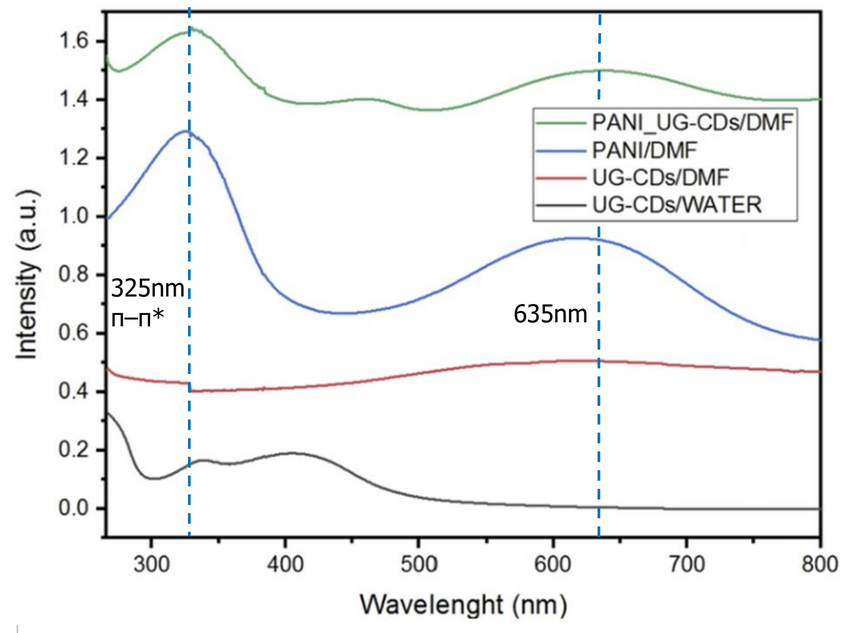

FIG4. UV-Vis absorption of synthesized materials.

In UV-vis spectra, PANI and PANI_UG-CDs/DMF exhibit an absorption band around 325nm, attributed to π–π* transitions. The peak around 635nm is attributed to the polaronic transition from the doping, in this case, HCl, H^+ ions from HCl protonate the imine nitrogen atoms (-NH-) in the PANI polymer chains, forming positively charged polaron sites along the polymer backbone [4]. The additional peak at 455nm arises from the successful embedding of CDs, associated with polaron-π*.UG-CDs/WATER shows also the π-π* transitions of the carbon core, a broad peak at 420 usually does not show up, it may be surface functional moieties, it may also be an effect of polyaromatic fluorophores created during the formation of CD via UG methods, the the strong peak at 250nm is right before saturation is due to π-π* transition [5].

Conclusions

PANI and PANI_UG-CDs were successfully synthesized via in-situ polymerization, where a more complex electronic structure shown by UV-Vis, is created without significant change in the secondary structure suggested by FTIR suggesting higher capacitance, with potential application for pseudocapacitors [6].

Future work

Bandgap analysis , Electrochemistry, Further characterisation

Reference

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