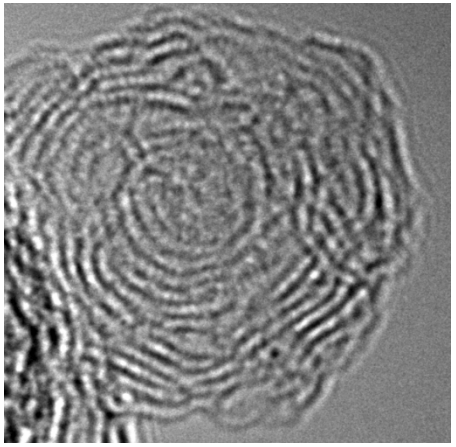
Multifunctional Water Soluble Carbon Nano Onions from Flaxseed Oil for Visible Light Induced Photocatalytic Applications and Label Free Detection of Al(III) Ions



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Trends in Nanotechnology

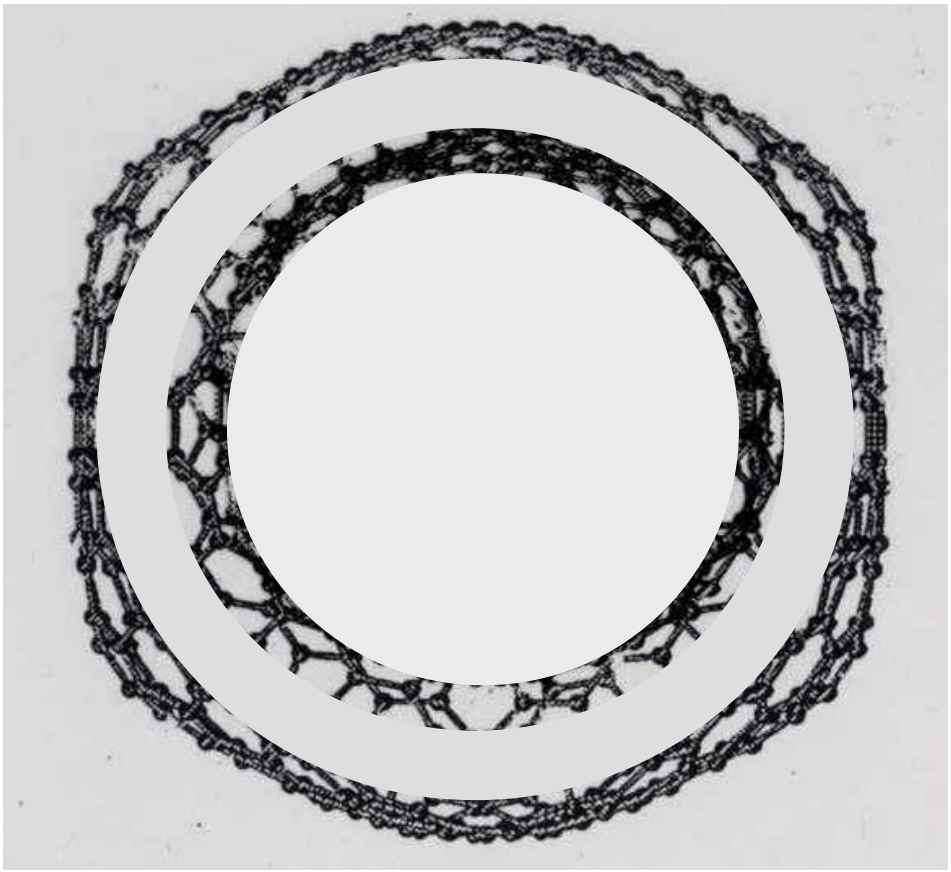
9-June-2017

What are Carbon Nano Onions

Japanese Scientist, S. Iijima (1980)

D. Ugarte (1992) Coined the word "Carbon Onions"

Multilayer giant fullerenes, which consist of multiple concentric graphitic shells to form encapsulated structures



In the electron microscope we only see the shell contours

Cost Effective Synthesis of Carbon Nano Onions

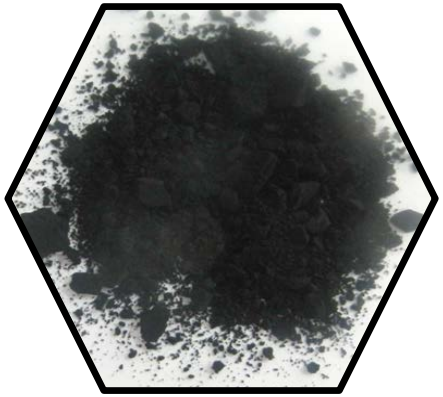
- Generally used sophisticated synthetic procedures are expensive, time consuming and often lead to the formation of metal deposited/contaminated nano-carbons.
- Our approach here is very simple, green and utilizes cost effective technique of wick pyrolysis.
- High yield synthesis with ease in reproducibility.
- Further oxidation with nitric acid leads to the formation of water soluble version of carbon nano onions and impart fluorescent.
- Amenable to surface modification/functionalization.
- Aqueous solubility makes these nano-carbons a potential candidate to explore their potentials in both environment and biomedical applications.

Fabrication of Carbon Nano Onions

Flaxseed oil

Wick

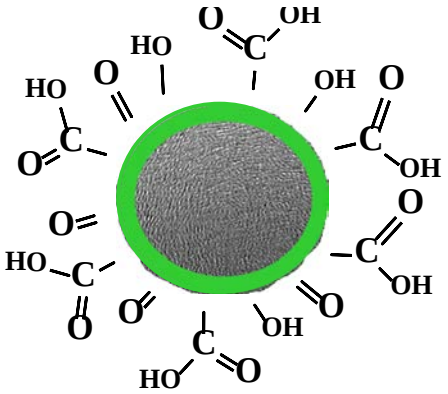
Pyrolysis



Carbon Nano Onions

[O]

HNO_3



Water soluble Carbon Nano Onions

Wick Pyrolysis of Flaxseed Oil & soot was collected

Refluxed in Conc. HNO_3 for 10 h

Purified by washing with water *via* centrifugation

Repeated Evaporation on water bath till pH = 7

Filter with 0.45, 0.2 & 0.1 µ membrane

Yield 85 %

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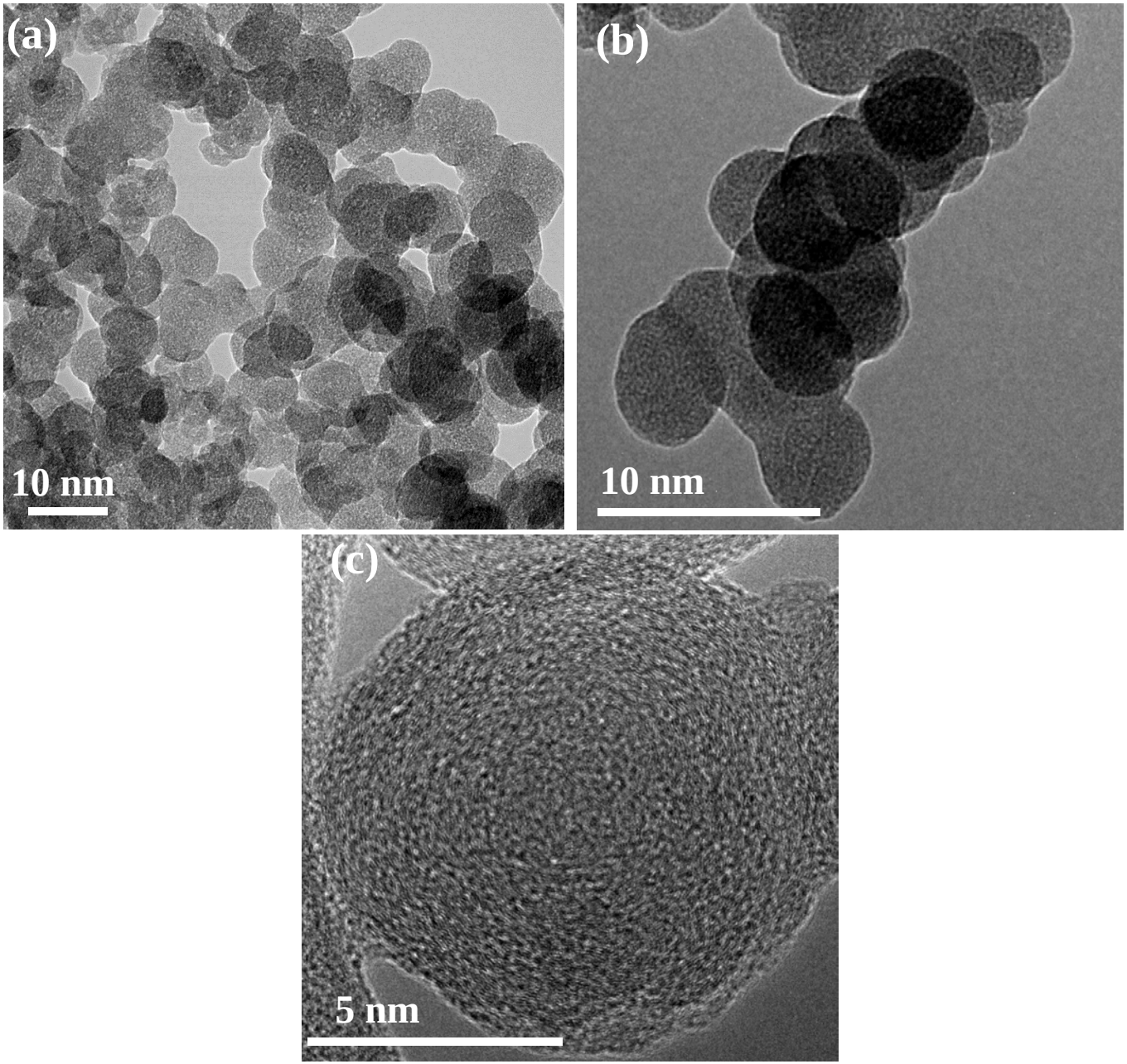
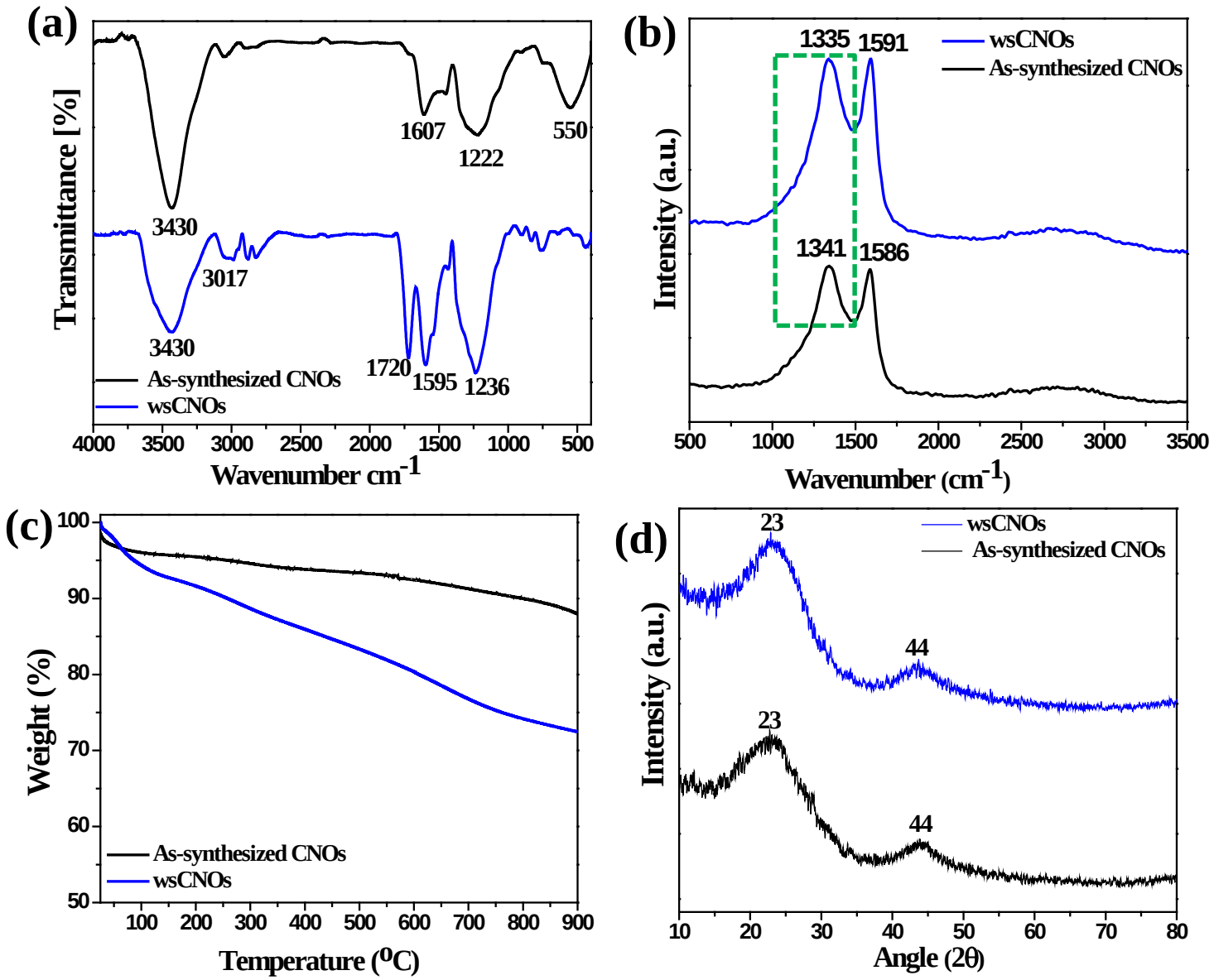
Microscopic Characterization

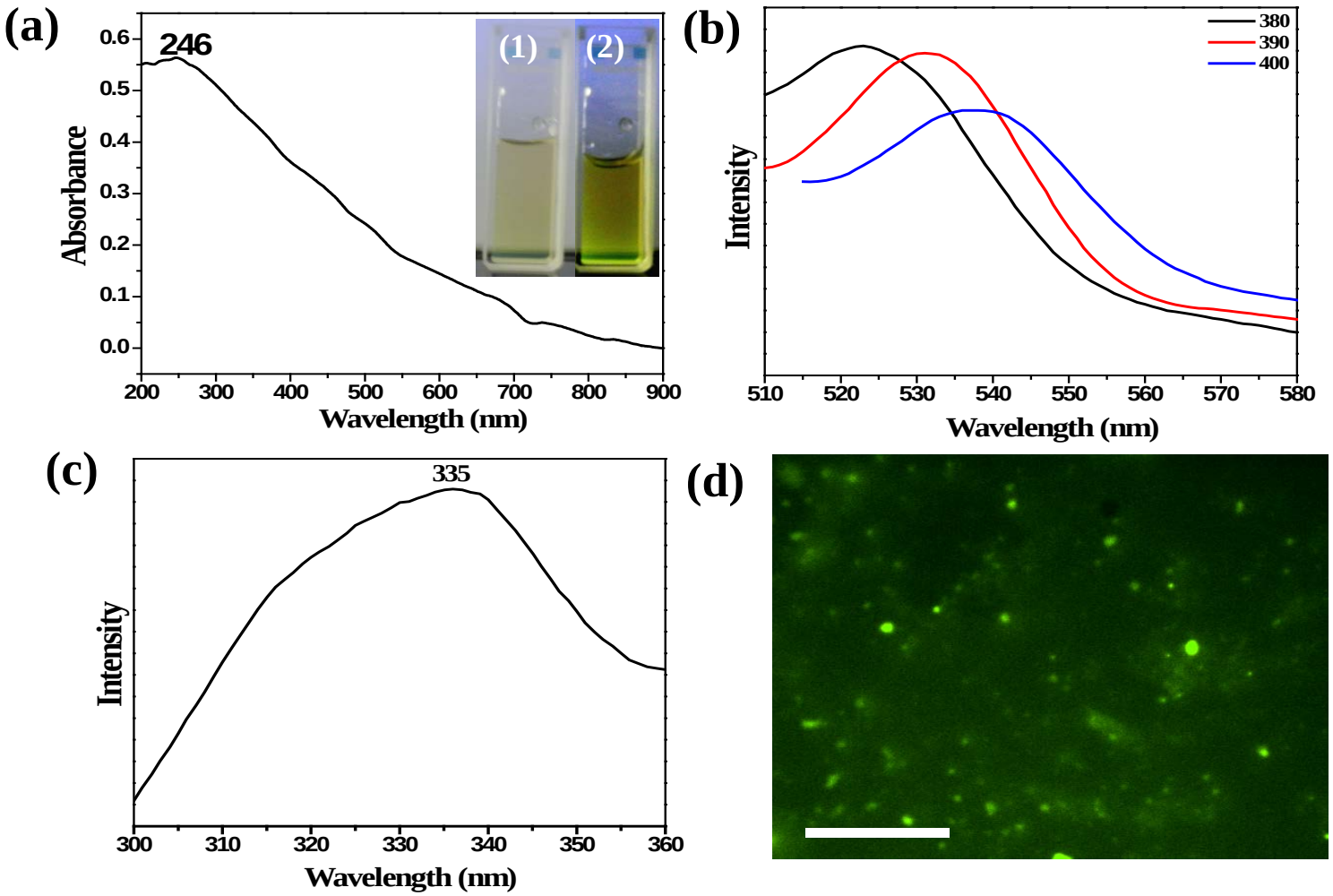


Spectroscopic Characterization



(a) FTIR **(b)** Raman **(c)** TGA and **(d)** XRD spectra of CNOs (black line) & wsCNOs (blue line)

Optical Characterization



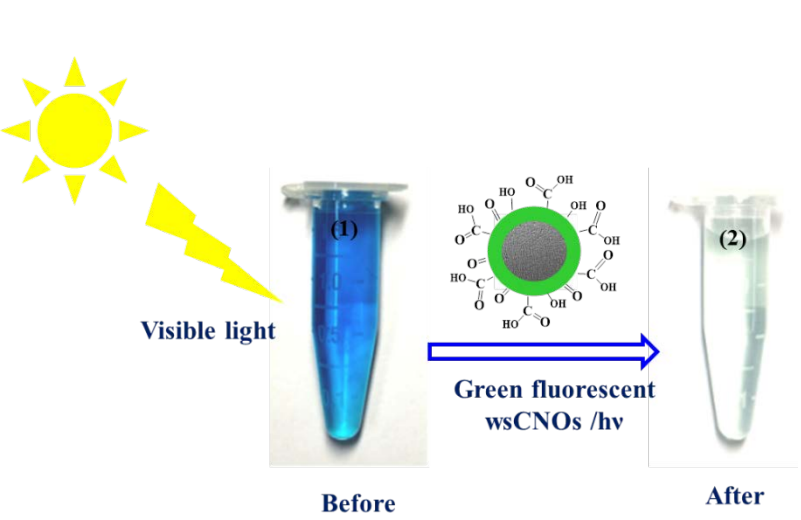
(a) UV-Vis absorption spectrum and digital image of an aqueous solution of wsCNOs under daylight, (2) under 385 nm λ_{ex};
(b) PL emission spectra at different wavelengths;
(c) PL excitation spectrum at a 523 nm emission wavelength;
(d) Fluorescence image of wsCNOs at 488 nm band pass filter, scale bar 20 μm.

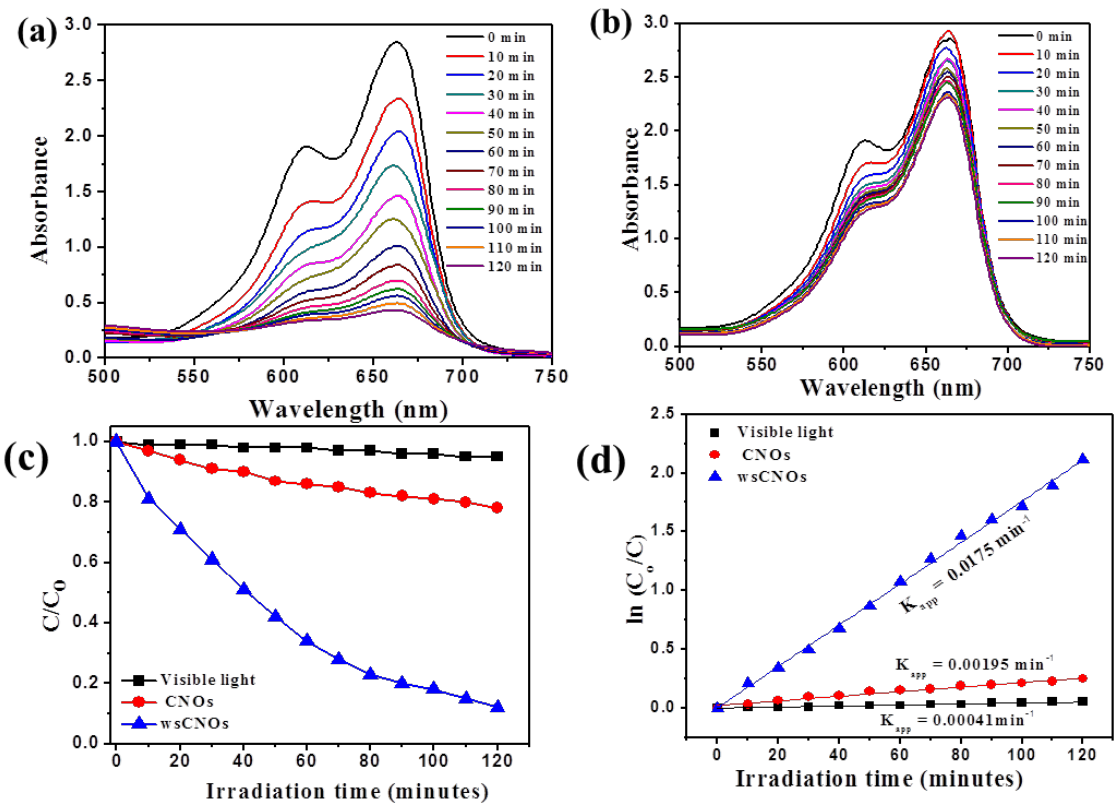
Utility of Water Soluble Carbon Nano Onions

- **In highly selective sensing of trace amount of Al(III) in homogenous aqueous medium with low detection limit.**

- **Photocatalytic degradation of toxic organic dyes for water remediation**

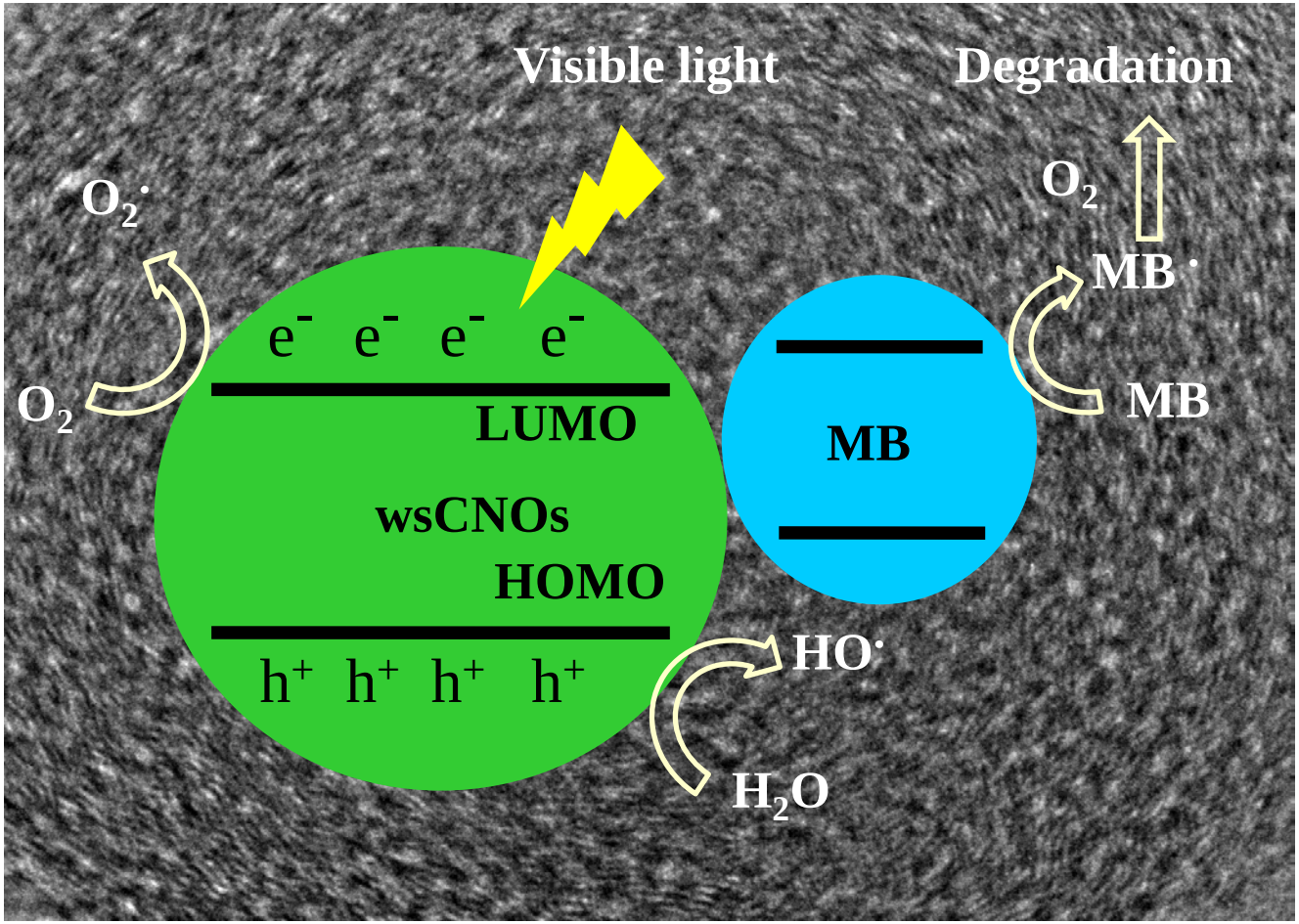
Application in photocatalytic dye degradation





UV-Vis absorbance spectra of methylene blue at set 10 minutes of time intervals with **(a)** wsCNOs and **(b)** CNOs. Extent of **(c)** MB photodegradation at different visible light irradiation time with CNOs and wsCNOs; **(d)** Plot of $\ln(C/C_o)$ for MB photodegradation with CNOs and wsCNOs .

Visible Light Induced Dye Degradation



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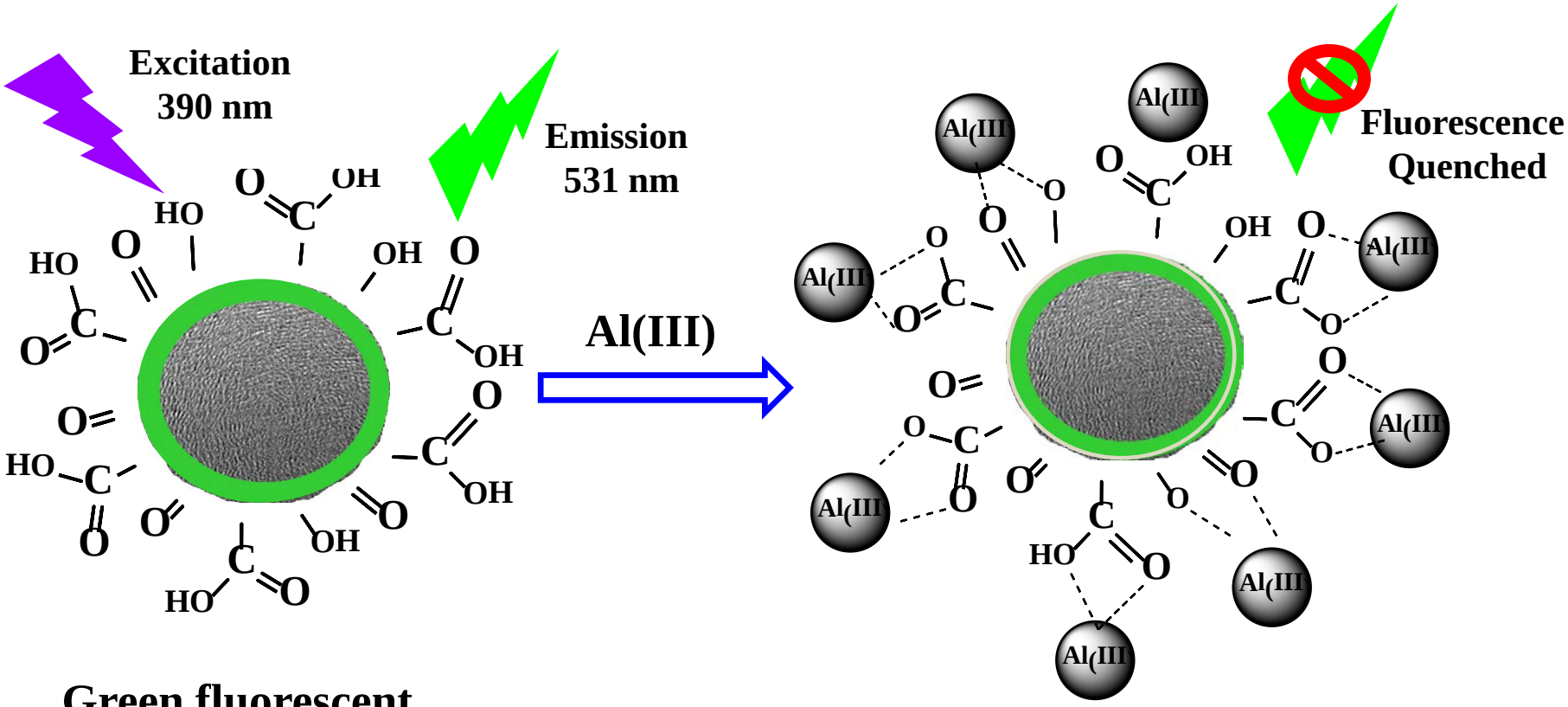
Application in Al(III) Sensing



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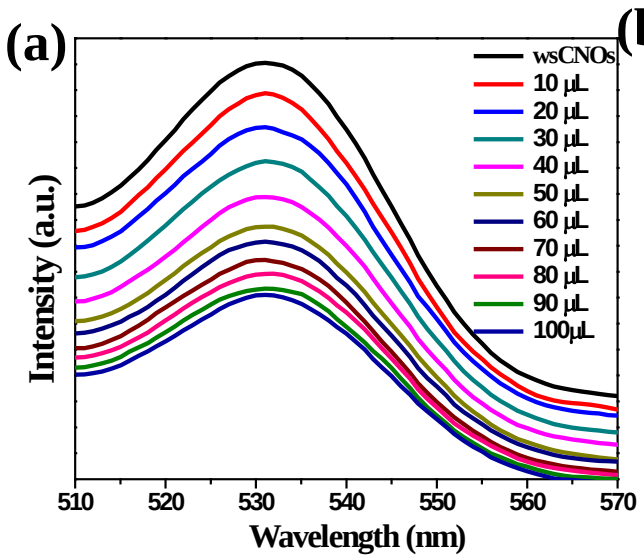
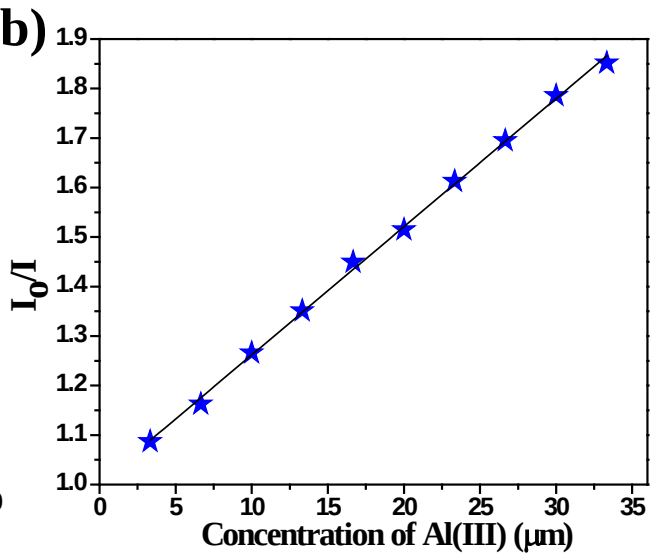
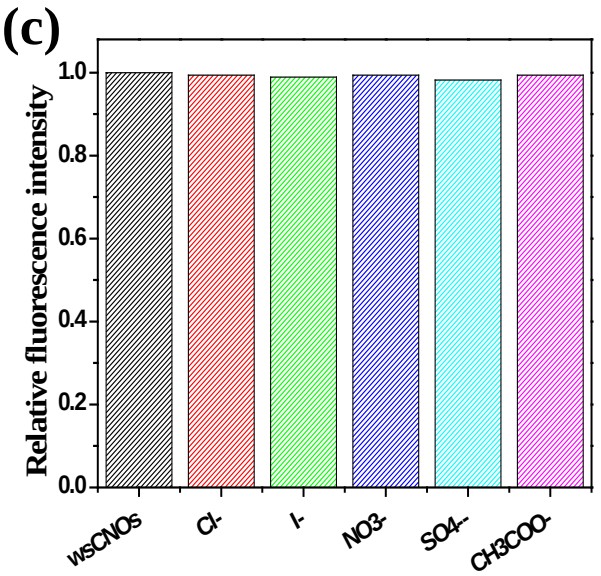
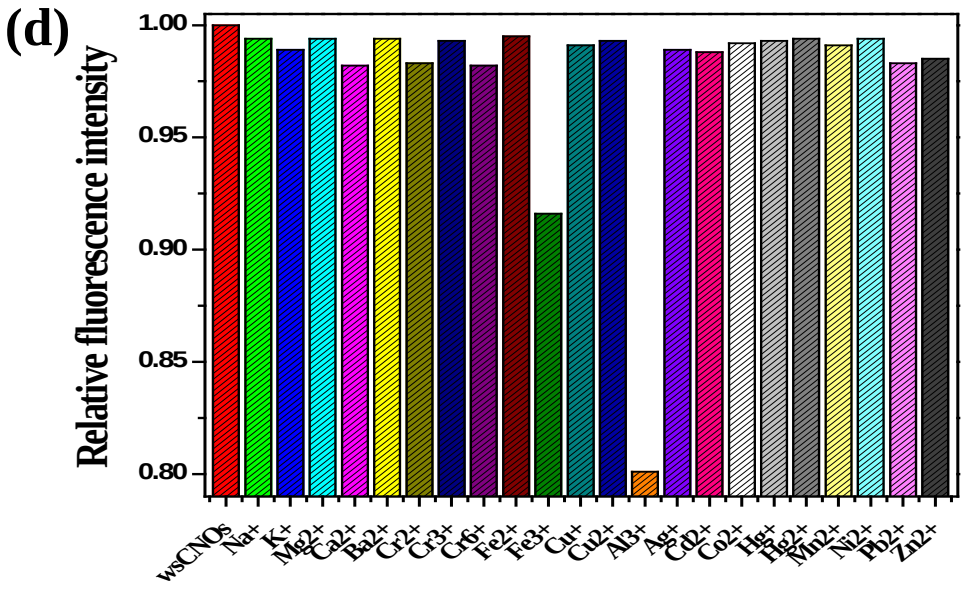
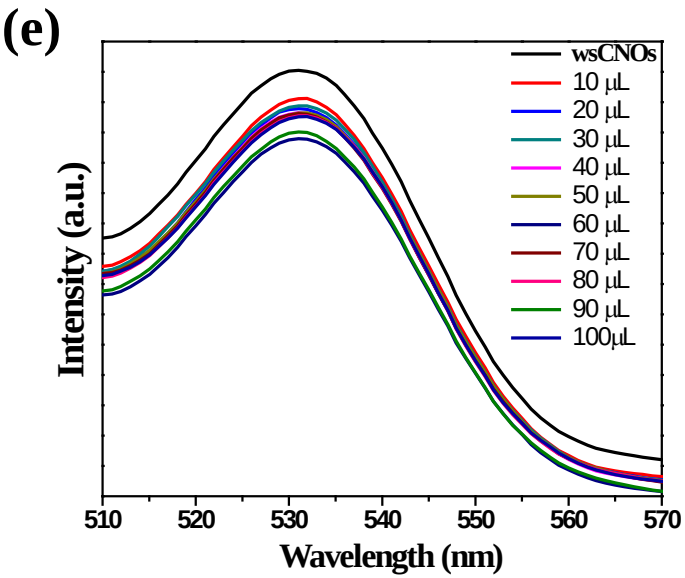
Application in Al(III) Sensing











Conclusion

- Facile synthetic route for the synthesis of homogenous wsCNOs by traditional pyrolysis of flaxseed oil as the carbon precursor.
- Further oxidation with HNO_3 leads to the formation of water soluble version of CNOs *via* functionalization with –COOH (surface defects) and further impart fluorescent.
- wsCNOs were characterized by TEM, HRTEM, FTIR, Raman, TGA, XRD and zeta potential studies .
- Interestingly synthesized CNOs displayed multifunctional applications in sensing and photocatalysis.
- wsCNOs used as a fluorescent probe for the sensitive detection of Al(III) ions based upon florescence "turn-off" technique with a 0.77 µm detection limit.
- wsCNOs exhibited excellent visible light driven photocatalytic performance towards degradation of organic dyes.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