Fluorescence Capabilities and Characterization of Oxidized Biochar Particles

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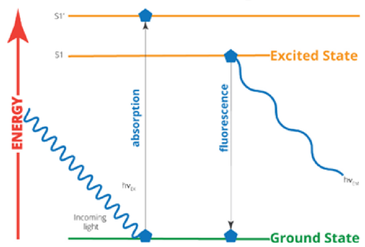
Abstract

Biochar is a made through a simple combustion method from any biomass. This research utilized biochar from 3 different biomass sources, as well as a green hydrothermal synthesis, to produce fluorescent carbon-based particles. Characterization of these particles were carried out using Infra-Red, Ultraviolet-Visible, Fluorescence, and Nuclear Magnetic Resonance spectroscopy. These particles are composed of a conjugated carbon lattice with nitrogen and multiple carbon-oxygen functional groups. The use of an economical and green synthesis that allows for the production of these oxidized particles with no waste or by-product, makes this compelling as a research focus.. The physical and fluorescence characteristics of these particles makes them an ideal candidate for future research into a safe, green, cost-effective biosensor.

Background

Research surrounding biochar is predominately focused around its ability to absorb pollutants and as an analogue to activated charcoal. When biochar is oxidized using hydrogen peroxide, fluorescent carbon-based particles are formed. The biochars used in this experiment originated from two wood and one straw biomasses.

Fluorescence Diagram

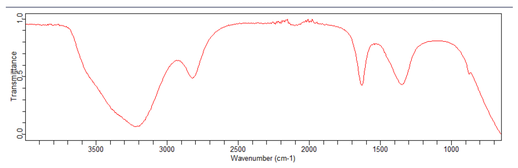


Method

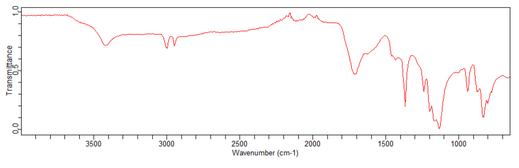
- Grind Biochar into powder
- Heat 0.02 biochar with 15mL of 50% hydrogen peroxide for 90 minutes.
- Cool room temperature
- Evaporate solution down
- to approximately 3mL
- Dialyze the solution
- Analyze Components

Results

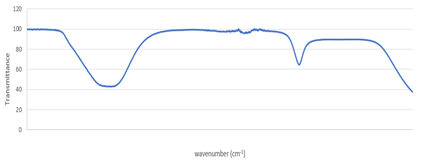
Representative IR spectra of oxidized biochar solutions before dialysis



Representative IR spectra of dried oxidized biochar solutions before dialysis



Representative IR Spectra of dialyslate



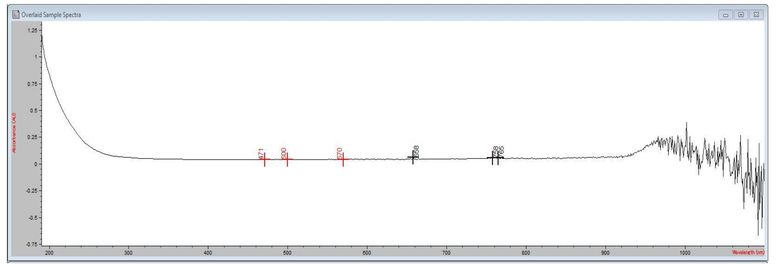
H-NMR Results

Bio #1	Bio #2	Bio #3
Carboxylic Acid	Carboxylic Acid	Carboxylic Acid
Ketone or Ester	Ketone or Ester	Ketone or Ester
Secondary Alkyl	Secondary Alkyl	Secondary Alkyl

C^{13}-NMR Results

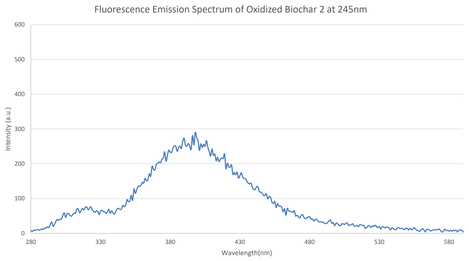
Biochar #1	Biochar #2	Biochar #3
R-CH_3	R-CH_3	R-CH_3
R-CH_2	R-CH_2	R-CH_2
C-N	C-N	C-N
Aromatic	Aromatic	Aromatic
Ketone	Ketone	Ketone

Representative UV-Vis Spectrum of oxidized biochar solutions

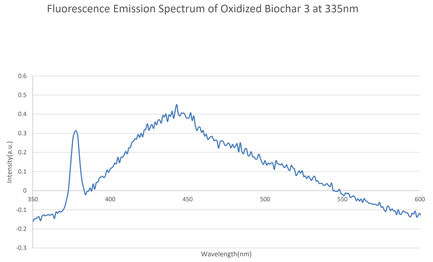


Fluorescence Emission Spectrum of Oxidized Biochar 1 at 230nm

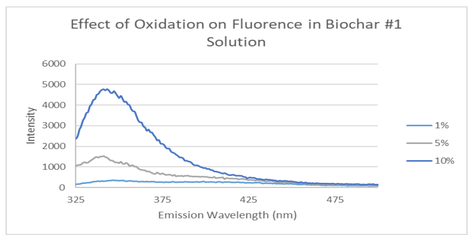
Fluorescence Emission Spectrum of Oxidized Biochar 2 at 245nm



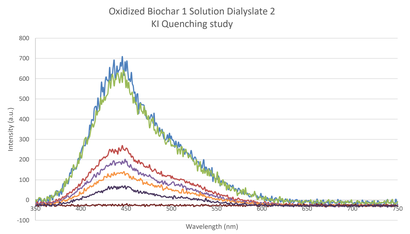
Fluorescence Emission Spectrum of Oxidized Biochar 3 at 335nm



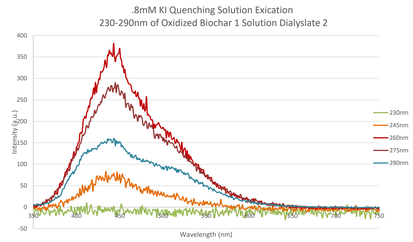
Effect of Oxidation on Fluorence in Biochar #1 Solution



Oxidized Biochar 1 Solution Dialyslate 2 KI Quenching study



.8mM KI Quenching Solution Exication 230-290nm of Oxidized Biochar 1 Solution Dialyslate 2



Conclusions

- Fluorescence in this solution most likely occurs due to an aromatic structure with oxygen functional groups.
- Strong, stable fluorescent behavior
- Similar fluorescent behavior and functional groups despite different biomass sources
- Approximately 2 peaks visible from fluorescence spectra
- Emission maximum in the 430-450nm region.

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