Investigation of eco-friendly, sustainable, natural resources for electrospun carbon nanofibers as energy storage materials

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Abstract

Choosing "green" and economically viable precursor and synthesis process for the production of carbon nanofibers would make them a sustainable alternative for energy storage applications. Nature provides a wide variety of renewable raw materials with diverse properties and chemical compositions. In this project, lignin as a biomass-derived carbon precursor was investigated for the production of electrospun carbon nanofibers.

Purpose of the Project

- Characterization of lignin as a biomass-derived carbon precursor
- Investigation of electrospinnability of lignin for the production of electrospun carbon nanofibers

Introduction

➢ **Lignin**

bio-waste of paper production

carbon rich polymer

carbon density of lignin allows its usage in the production of carbon nanofiber

➢ **Poly vinyl alcohol (PVA)**

water soluble synthetic polymer

➢ **Polyacrylonitrile (PAN)**

synthetic, semicrystalinne organic polymer

➢ **Electrospinning**

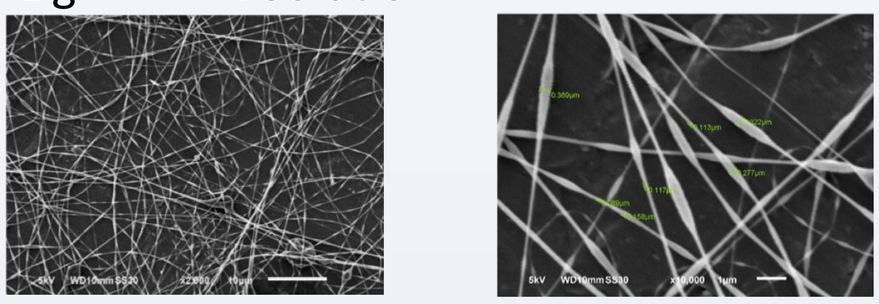
method to produce ultrafine fibers by charging and ejecting a polymer melt or solution under a high voltage electric field

Methods

- Solution preparation Lignin/PVA, Lignin/PAN and Lignin/PVP
- Nanofibers production using elecrospinning
- Characterization of lignin and lignin-based nanofibers via
  - Scanning electron microscopy (SEM)
  - Fourier Transform Infrared Spectroscopy (FTIR)
  - Proton Nuclear Magnetic Resonance (^{1}H NMR)
  - Thermogravimetric Analysis (TGA)

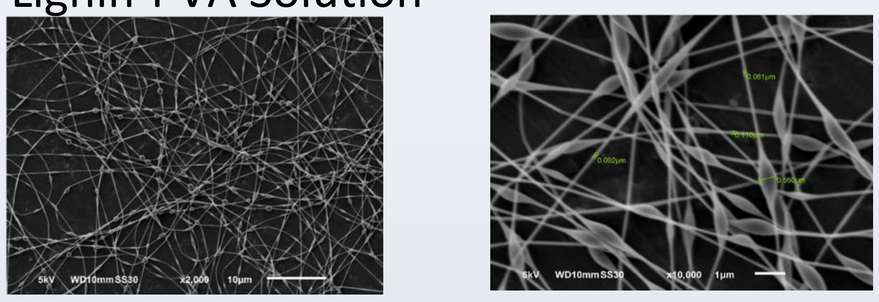
SEM

Lignin-PAN Solution



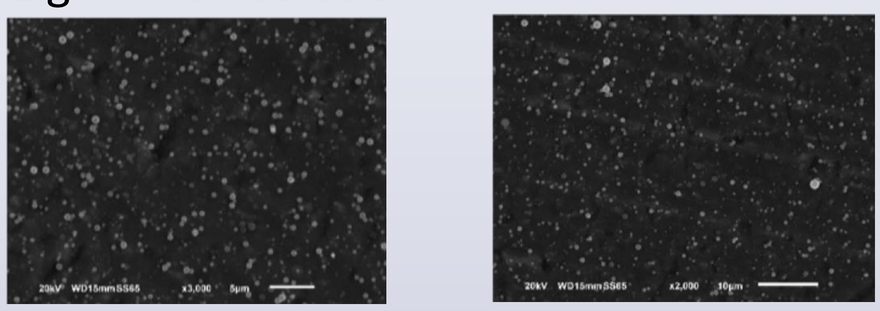
LSEM images of nanofibers from Lignin-PAN solution (magnification times 2000X, 10000X).

Lignin-PVA Solution



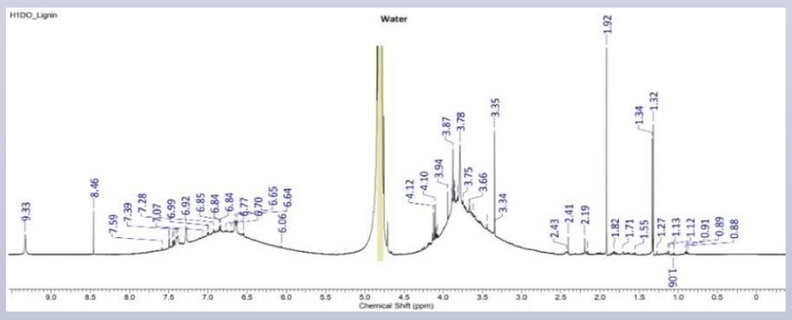
SEM images of nanofibers from Lignin-PVA solution (magnification times 2000X, 10000X).

Lignin-PVP Solution

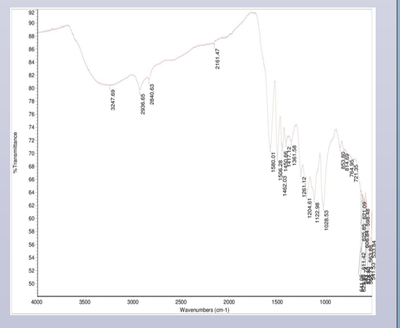


SEM images of nanofibers from Lignin-PVP solution (magnification times 3000X, 2000X).

^{1}H NMR



FTIR



Summary

- Lignin was characterized via NMR and FTIR
- Four types of solution were prepared
  Lignin-PAN-DMF with a 10% solid weight ratio
  Lignin-PVA with a 10% solid weight ration
  Lignin-PVP with 8% and 10% solid weight ratio
- Electrospinning technique was used to produce nanofibers

Future Works

- Effect of surfactants will be investigated for nanofiber production.
- Carbonization of lignin-based nanofibers will be performed.
- Electrochemical performances of lignin-based carbon nanofibers will be investigated in Li-ion battery cells