Nanofiber/Natural Clay Nanocomposites via Green Electrospinning

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Abstract

- Optimization of "waterborne polyurethane" (WBPU) and "halloysite nanotubes (HNT)" composite solution.
- Loading an antibacterial agent into HNT.
- Electrospinning polymer nanofiber/polymer + HNT nanofibers
- Characterization

Purpose of Project

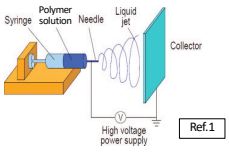
- To investigate HNT/WBPU composite nanofiber
- To investigate antibacterial properties of C-HNT/WBPU composite nanofibers

Introduction

- **Waterborne Polyurethane (WBPU)**
  - Water-based polyurethane dispersion
  - Ecofriendly, no organic solvents
  - Economical and safer than conventional polyurethanes
  - Similar properties to solvent-based counterparts
  - Since it is a dispersion, it requires a carrier polymer for electrospinning
- **Poly(vinyl alcohol) (PVA)**
  - Water soluble, biocompatible polymer
- **Electrospinning**
  - Powerful tool to produce ultra-thin fibers from a wide range of polymeric materials.
  - Electrospun nanofibers with very large surface area to volume ratio, flexibility and superior mechanical performance
- **Halloysite Nanotube (HNT)**
  - Natural clay with high mechanical strength, thermal stability, biocompatibility and abundance
  - Tubular microstructure provides good drug encapsulation and sustained release ability

Methods

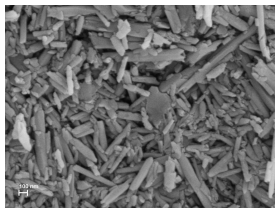
- Purification of HNT
- Carvacrol loading into HNT
- Solution preparation PVA/WBPU and PVA/WBU/HNT
- Electrospinning



- Characterization via
  - Scanning Electron Microscopy (SEM)
  - Energy-dispersive X-ray Spectroscopy (EDX)
  - Thermogravimetric Analysis (TGA)
  - Fourier Transform Infrared Spectrophotometer (FTIR)
- Bio test via
  - Viability Assay

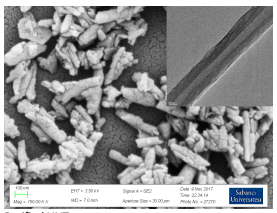
Optimization of Electrospun of WBPU/ PVA/HNT Composite Solution

Investigation of HNT's from different sources

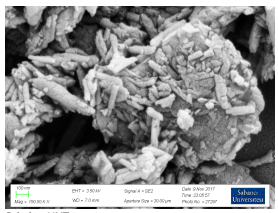


a. HNT's provided by Sigma-Aldrich

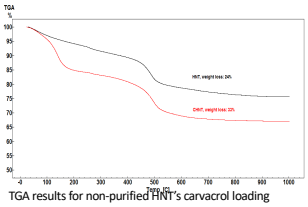
- HNT Carvacrol load failed for commercial HNT.
- Non-purified HNT investigated for carvacrol loading and presence in fibers.
- Carvacrol loading inside non-purified HNT succeed.



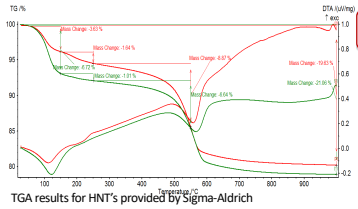
Purified HNT



Pristine HNT

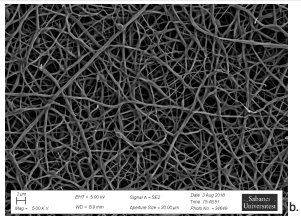


TGA results for non-purified HNT's carvacrol loading



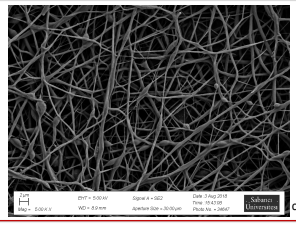
TGA results for HNT's provided by Sigma-Aldrich carvacrol loading

WBPU:PVA 7/3 H.M.W. %17



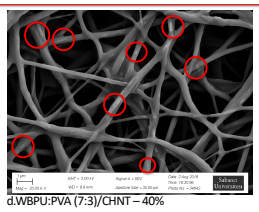
b.

WBPU:PVA 7/3 H.M.W. %17 - CHNT %40



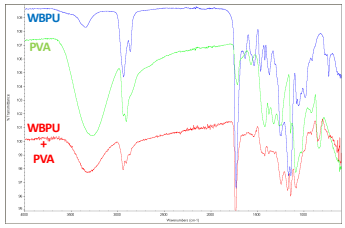
c.

WBPU/PVA/HNT

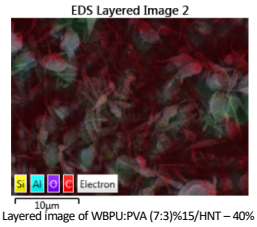


d.WBPU:PVA (7:3)/CHNT – 40%

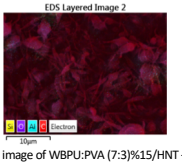
FTIR



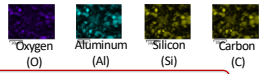
WBPU/PVA/HNT (EDX)



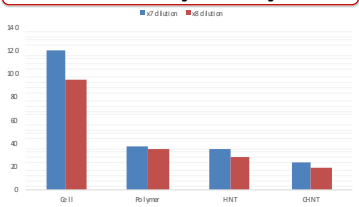
Layered image of WBPU:PVA (7:3)%15/HNT – 40%

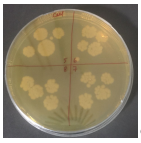


2. Layered image of WBPU:PVA (7:3)%15/HNT – 40%

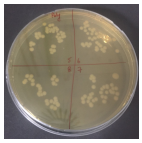


Viability Assay

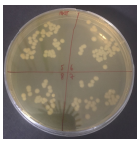




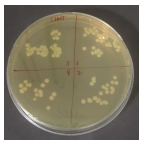
e. cell



f. polymer



g. HNT



h. CHNT

Summary

- WBPU/PVA solution conditions were optimized
- 1 % to 40 % HNT were successfully incorporated into WBPU/PVA nanofibers
- HNT's were loaded with carvacrol (ABA) and incorporated into WBPU/PVA nanofibers
- Bio tests were executed and the antibacterial effect was noticed
- HNT's from different sources investigated and HNT optimization was done.

Future Works

- Mechanical properties of the designed nanofibers will be analyzed
- Antibacterial agent release profiles will be investigated further
- Controlled release properties will be investigated

Acknowledgements

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References

1. Park, J-S. (2011). Electrospinning and Its Applications. *Advances in Natural Sciences: Nanoscience and Nanotechnology, 1(4):* 43002