Route to conducting nanocomposites by simultaneous *in situ* polymerization of aniline and matrix assembly from bacterial cellulose nanowhiskers

**Divya Anand, Dr. Mudrika Khandelwal**
Department of Materials Science and Metallurgical Engineering
Indian Institute of Technology, Hyderabad
Ordinance Factory Estate, Yeddumailaram, Medak, Telangana 502205
1Email address: ms13m1004@iith.ac.in
2Email address: mudrika@iith.ac.in

Development of new greener material for conducting paper is sought for applications such as security paper, actuators, and anti-static packaging. It is required that the material for these applications possess low density and good mechanical integrity. This work presents a way to produce bacterial nanocellulose (BC) - polyaniline (PANI) nanocomposites by *in situ* polymerization of aniline in suspension of cellulose nanowhiskers. The BC/PANI composites formed by optimized synthesis of PANI within cellulose nanowhiskers are expected to possess good electrical conductivity in addition to excellent mechanical properties and flexibility. The material has been characterized using FTIR, SEM and 4-probe conductivity measurement equipment.

**ABSTRACT**

EXPERIMENTS

Low density
- Conducting polymer (eg polypyrrole, polyaniline)
- Conducting nanocomposites

Low weight
- Mechanical integrity
- Porosity and permeability
- Low environmental impact
- Manipulability
- Low cost

Conducting Polymer + polymeric substrate

SUBSTRATE

Figure 1: Characteristics for the materials to be used for flexible electronics application

RESULTS & DISCUSSION

1. Polyaniline Synthesis Optimisation

- Synthesis variables
  - Solvents (Acid+water/toluene+water)
  - Molar ratio of APS:Aniline
  - Time and temperature of polymerization
  - Washing and drying time

- Figure 3: Experiments planned for obtaining protocol for highly conducting PANI

- Figure 4: FTIR Spectra for experiment (a) set 1 & (b) set 2 with indicated molar ratios
  - The FTIR confirms the formation of polyaniline as the peaks for required functional groups were observed in 1:1,1:3 and 3:1, out of which yield is best for molar ratio 1:1.

2. Composite Preparation

a. From Bacterial Cellulose Sheet

- Figure 5: Composite Preparation from BC sheet (a) BC dipped in Aniline solution (b) then in APS solution (c) kept at low temperature for polymerization and (d) dried at higher temperature

A good coating of polyaniline can be observed on BC as seen from SEM image of the composite.

b. From Nanowhiskers

- Figure 6: Composite Preparation from BC sheet (a) BC Sheet (b) Acid hydrolysed (c) washing to obtain nanowhiskers (d) mixing all ingredients for sheet preparation

In this method, the matrix assembly takes place along with polymerization.

CONCLUSIONS & FUTURE WORK

- Optimised synthesis protocol for conducting polyaniline is 1:1 due to high yield and formation of conductive polyaniline which was confirmed via FTIR.
- Nanowhiskers are better substrate than Sheet form of BC due to its homogeneity which is expected due to uniform chemistry.
- Optimization for several perimeters have to be done in near future.

ACKNOWLEDGEMENT

- I thank my seniors (Ravi and Dan Satyaraj) for helping me using FTIR and SEM respectively.