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

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ABSTRACT

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.

EXPERIMENTS

LOW DENSITY POLYMER

CONDUCTING POLYMERS (eg polypyrrole, polyaniline)

BUT

NO MECHANICAL INTERGRITY

+ SUBSTRATE

LOW WEIGHT
MECHANICAL INTEGRITY
POROSITY AND PERMEABILITY
LOW ENVIRONMENTAL IMPACT
MANIPULABILITY
LOW COST

→ Conducting Polymer + polymeric substrate

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

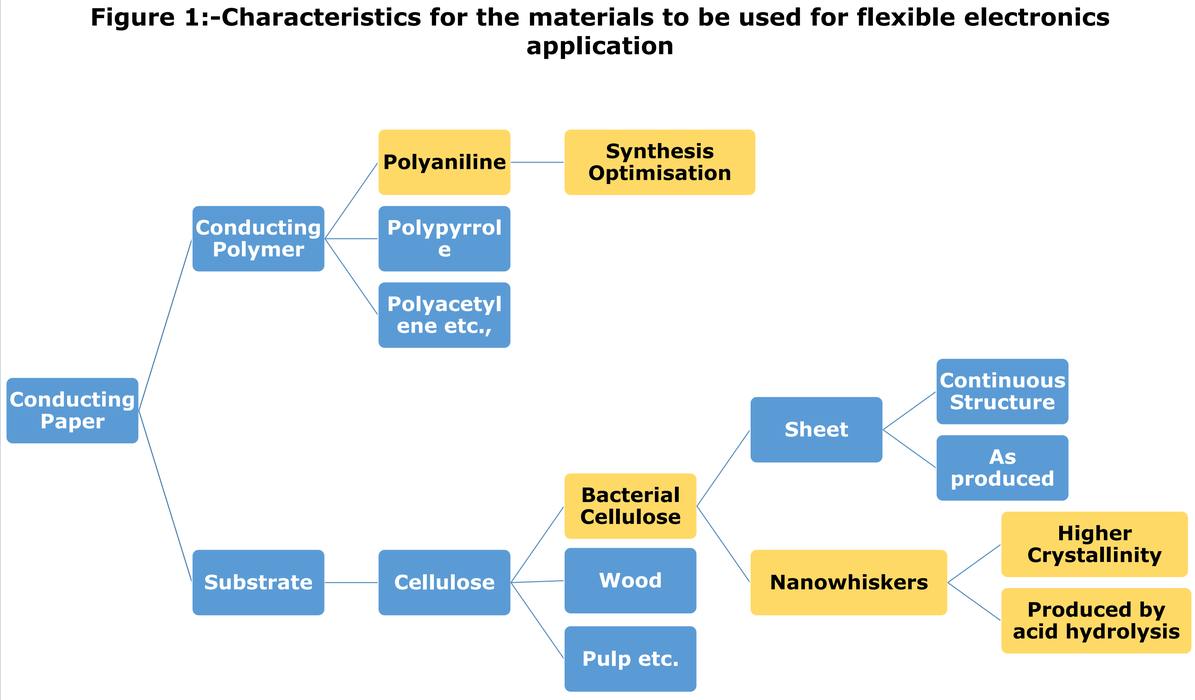


Figure 2:-Components of Polymer Composite for Conducting Paper

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

Solvents

APS	Aniline
water	acid
water	toluene

Experiment 1	5:1 1:1 1:5	APS in water and Aniline in acid
Experiment 2	3:1 1:1 1:3	APS in water and Aniline in toluene

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

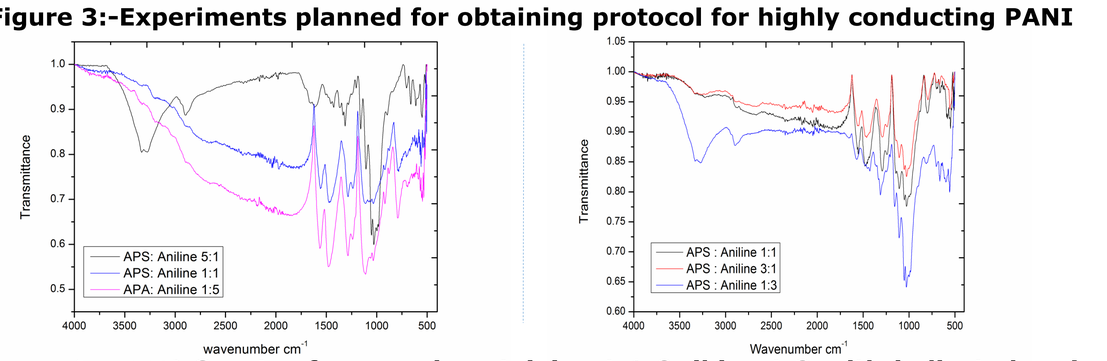
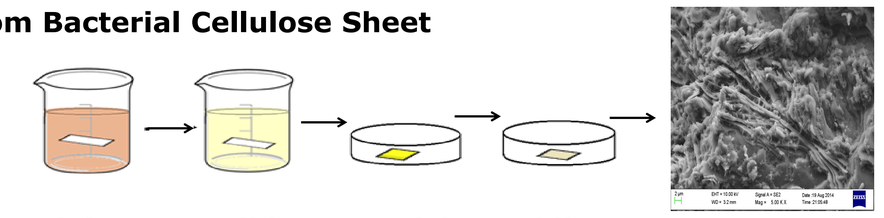


Figure 4:- FTIR Spectra for experiment (a) set 1 & (b) set 2 with indicated molar ratios

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

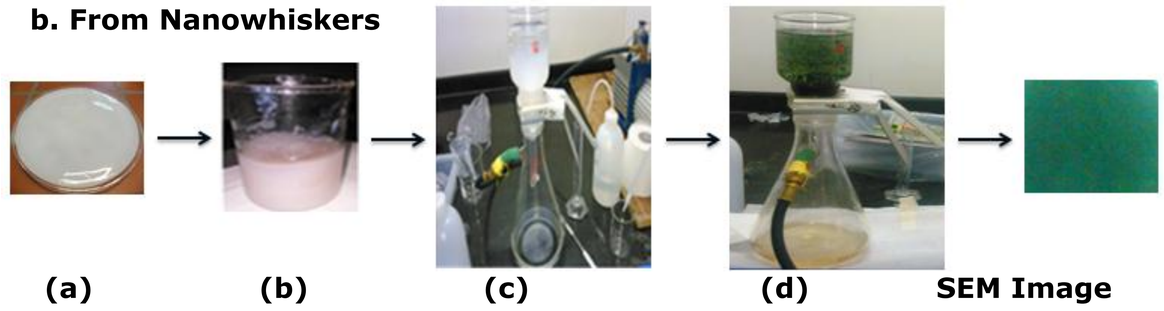


(a) (b) (c) (d) SEM Image

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



(a) (b) (c) (d) SEM Image

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

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.**

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