# Acrylic Polymers Surface Grafting of Acetylated Bacterial Cellulose Nanofibers By Free Radical Polymerization

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## Introduction

Bacterial Cellulose (B.C.) nanofibers are relatively strong, having breaking strengths of up to 1GN/m$^2$ (10,000 MPa). This B.C. is produced in the form of nanofibres, yielding a very pure cellulose product with unique physical properties that distinguish it from plant-derived cellulose. Although B.C. nanofibers have useful properties, it lacks properties of synthetic polymers. Modification of cellulose by graft copolymerisation also provides significant route to alter the physical and chemical properties in addition to promoting more stable biocomposites.

## Experimental Work

✓ Bacterial Cellulose was produced in shake flasks using a fructose-based medium by *Acetobacter Xylinum* BPR 2001 (ATCC # 700178).
✓ B.C. nanofibers were heterogeneously acetylated by fibrous acetylation method.
✓ Graft copolymerization of HEMA monomer onto the cellulose acetate (C.A.) was carried with a benzoyl-peroxide free-radical initiator.

## Free-Radical Graft Co-Polymerization Mechanism

$$C_6H_5OCO{-}OCO_6H_5 \xrightarrow[60\ ^\circ C]{\triangle} 2C_6H_5OCO^*$$

$$2C_6H_5OCO^* \longrightarrow 2C_6H_5{}^* + 2CO_2\uparrow$$

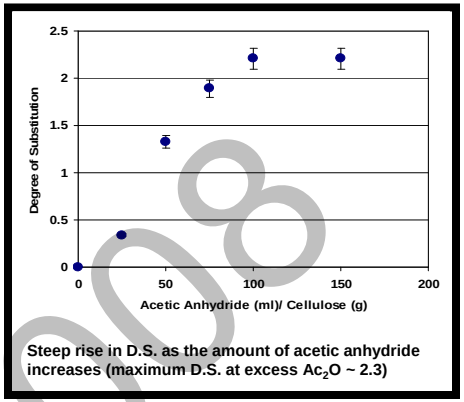
$$CA{-}OH + C_6H_5{}^* \longrightarrow CA{-}O^* + C_6H_6$$

$$CA{-}O^* + M \longrightarrow CA{-}O{-}M^*$$

$$CA{-}O{-}M^* + nM \longrightarrow CA{-}O{-}M^*_{(n+1)}$$

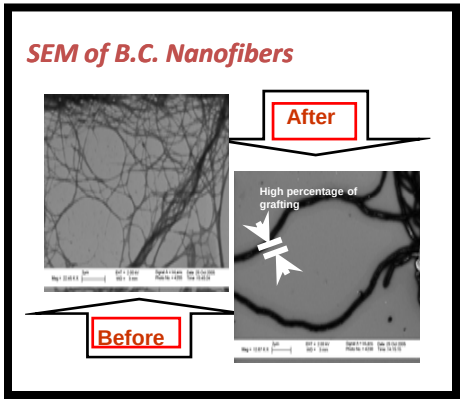
$$CA{-}O{-}M^*_{(n+1)} + CA{-}O{-}M^*_{(m+1)} \longrightarrow \text{Grafted Polymer}$$

where CA-OH is cellulose acetate, CA-O* is the cellulose acetate radicals, CA-OM* is the graft copolymer radical, and M is HEMA monomer.



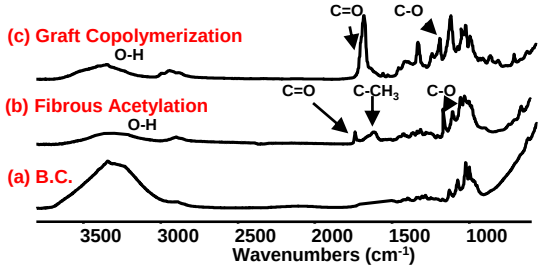

Steep rise in D.S. as the amount of acetic anhydride increases (maximum D.S. at excess $Ac_2O$ ~ 2.3)

### SEM of B.C. Nanofibers

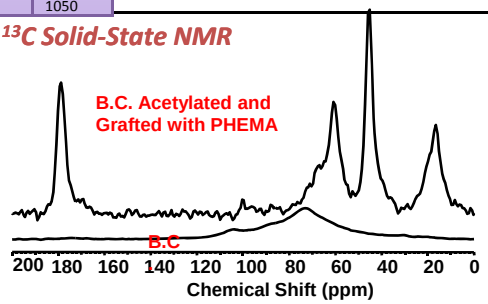



| B.C. | | C.A. | |
|---|---|---|---|
| *Group* | *(cm$^{-1}$)* | *Group* | *(cm$^{-1}$)* |
| OH stretching | 3345 | OH stretching | 3345 |
| CH stretching | 2900 | C=O stretching | 1730 |
| OH bending of adsorbed water | 1638 | CH3 asymmetric deformation | 1450 |
| HCH and OCH in-plane bending vibration | 1420 | CH3 symmetric deformation | 1375 |
| | | Acetate C-C-O stretching | 1250 |
| | | C-O stretching | 1050 |

### FTIR Of Modified B.C.




### $^{13}C$ Solid-State NMR




## References

**1.** Joseph et al., J. Chem Tech Biotech 2003, 78:964-970. **2.** Kim et al., Cellulose 2002; 9: 361-367. **3.** Carlmark et al., Biomacro. 2003; 4: 1740-1745.