

# Cellulose Nanocrystal Reinforced Electrospun Composite Nanofibres

Muhammad Ichwan

BCI Showcase

13<sup>th</sup> April 2021

[bristol.ac.uk/composites](http://bristol.ac.uk/composites)



*Indonesia Endowment Fund for Education*

# 1. Introduction

## 1.1 Research background

- The potential use of cellulose nanocrystals (CNCs) from Oil Palm waste as reinforcement for electrospun composite nanofibres to improve the fracture toughness of composite laminates

## 1.2 Aim of Research

- To study the reinforcement potential of CNCs from a commercial product and OPEFB on electrospun composite nanofibres and composite laminates

# 2. Experimental method

## 2.1 Isolation of CNCs from Oil Palm Empty Fruit Bunches (OPEFB)



## 2.2 Emulsion electrospinning of CNCs reinforced Cellulose Acetate Butyrate composite nanofibres

- Cellulose acetate butyrate 5 wt.% (matrix)
- CNCs 0-2.5% vol.fraction (filler)
- Chloroform/Benzyl Alcohol mixture (solvent)

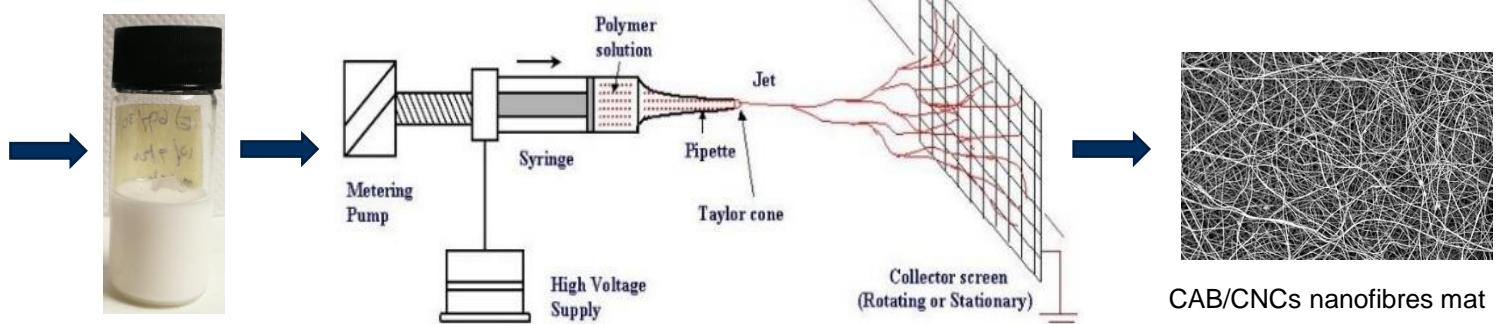
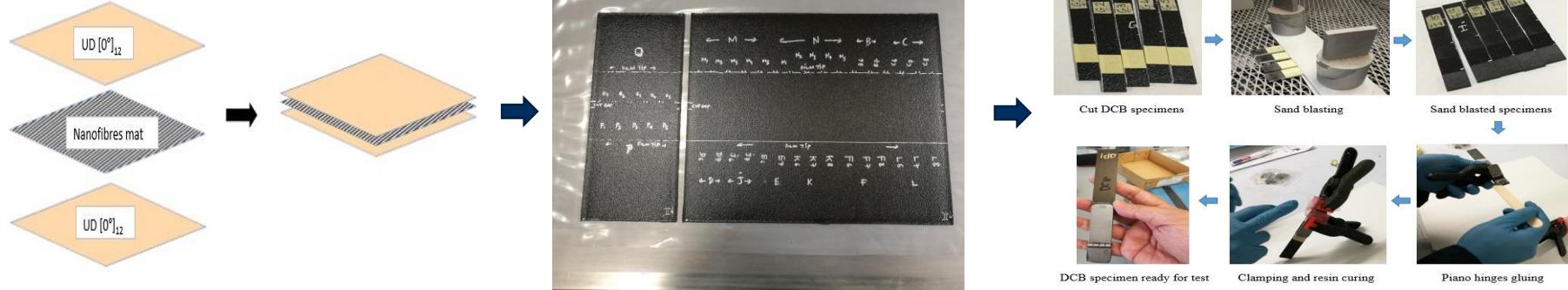


Figure 1. Schematic of the Electrospinning setup.

# 2. Experimental method (cont)

## 2.3 Interleaving CAB/CNCs nanofibres mat into Epoxy/Carbon laminate



Preparation of DCB specimens

## 2.4 Interlaminar Fracture Toughness Mode I and Mode II test on CAB/CNCs into Epoxy/Carbon laminate



IFT Mode I (DCB) test



IFT Mode II (ENF) test

# 3.Result

## 3.1.Mechanical properties of CAB/CNCs composite nanofibres

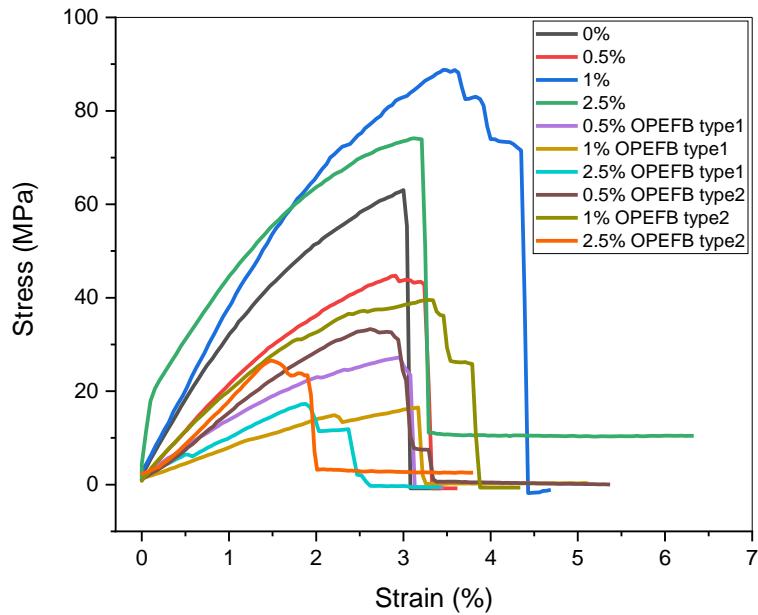


Fig.1.Typical stress-strain curve of CAB/CNCs/BnOH random nanofibres composites with CNCs type and different CNCs volume fractions

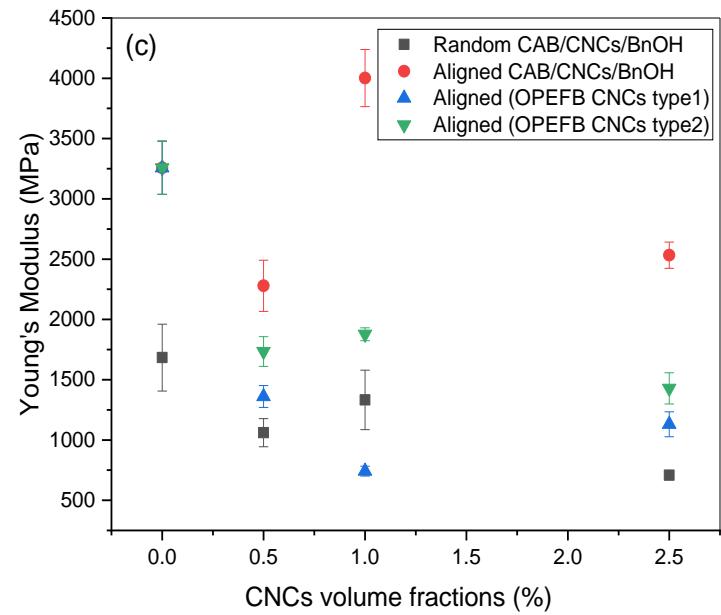


Fig.2.Young's Modulus comparison of random and aligned CAB/CNCs nanofibres composites with different different CNCs type and volume fractions

# 3.Result (Cont 1)

## 3.2. Interlaminar Fracture Toughness Mode I and Mode II of CAB/CNCs interleave in Epoxy/Carbon laminate

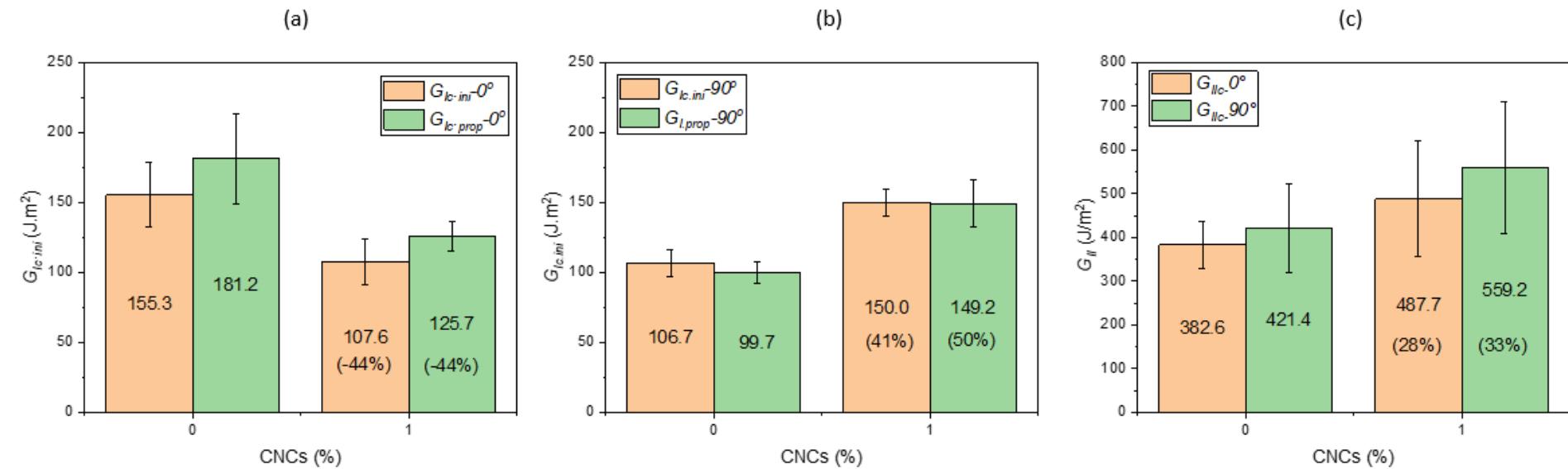


Fig.3 interlaminar fracture toughness Mode I ( $G_{Ic}$ ) with interleave orientation of (a)  $0^\circ$ , (b)  $90^\circ$  to crack propagation; and interlaminar fracture toughness Mode II (c) with interleave orientation of  $0^\circ$  and  $90^\circ$  to crack propagation

# 4. Conclusion

- The reinforcement capability of Commercial CNCs as filler in electrospun composite nanofibres at 1% volume fraction is higher than OPEFB CNCs type 2 > OPEFB type 1
- Interleaving CAB/CNCs composite nanofibres at 1% volume fraction improve interlaminar fracture toughness Mode I and Mode II of epoxy/carbon laminate
- Interleave orientation of 90° to crack propagation improve IFT Mode I and Mode II effectively than 0°orientation

# Acknowledgements

- The authors would like to acknowledge LPDP (Indonesia Endowment Fund for Education) for their support of this research through the Composites University Technology Centre at the University of Bristol, UK

# Thank you

Muhammad Ichwan  
[mi17585@bristol.ac.uk](mailto:mi17585@bristol.ac.uk)

[bristol.ac.uk/composites](http://bristol.ac.uk/composites)