

# Novel multi-layer oil-resistant food serving plates using nanocellulose composite

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- From 1950-2015, **6300 ton** plastic waste has been generated
- **12000 ton** by 2050
- **70%** of global plastic production are made up of **disposable** plates, straws, cups etc.
- By **2050**, there will be **more plastics than fish** in the oceans.



Image courtesy: greenpeace.org

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- 
- Replacement of plastic
  - Biodegradable
  - Water resistance
  - Durable
  - Grease and oil resistance

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- Expensive
  - Contains PFAS (per- and poly fluoroalkyl substances) or other Volatile Organic Compounds (VOCs)



**Goal: To develop a grease/oil resistant food serving plate predominantly made from wood flour and which are PFA free**



**Wood pulp**



**Wood flour**

**Price of wood pulp >> Price of wood flour**

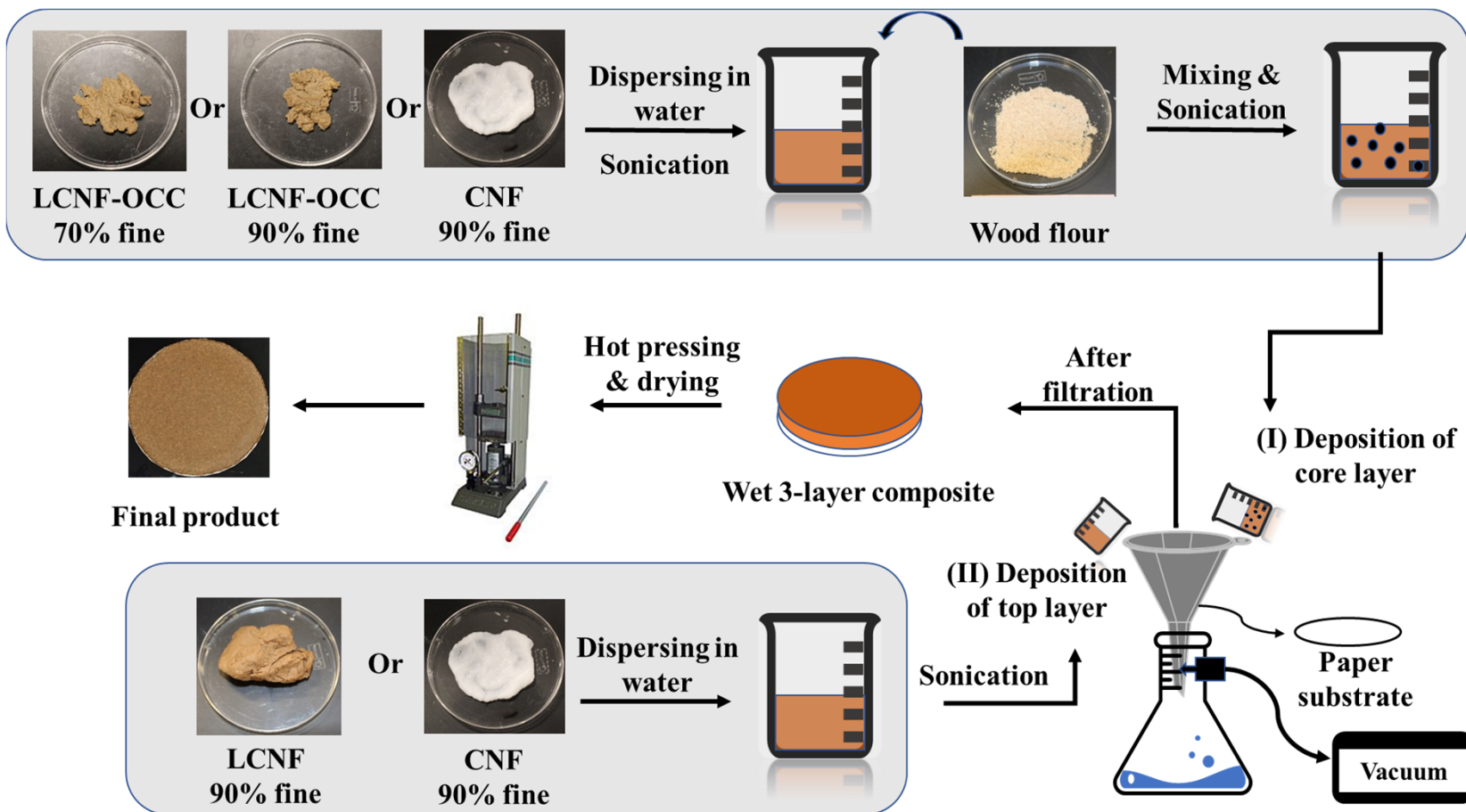


Fig: Fabrication process of nanofiber coated oil and grease resistant plates



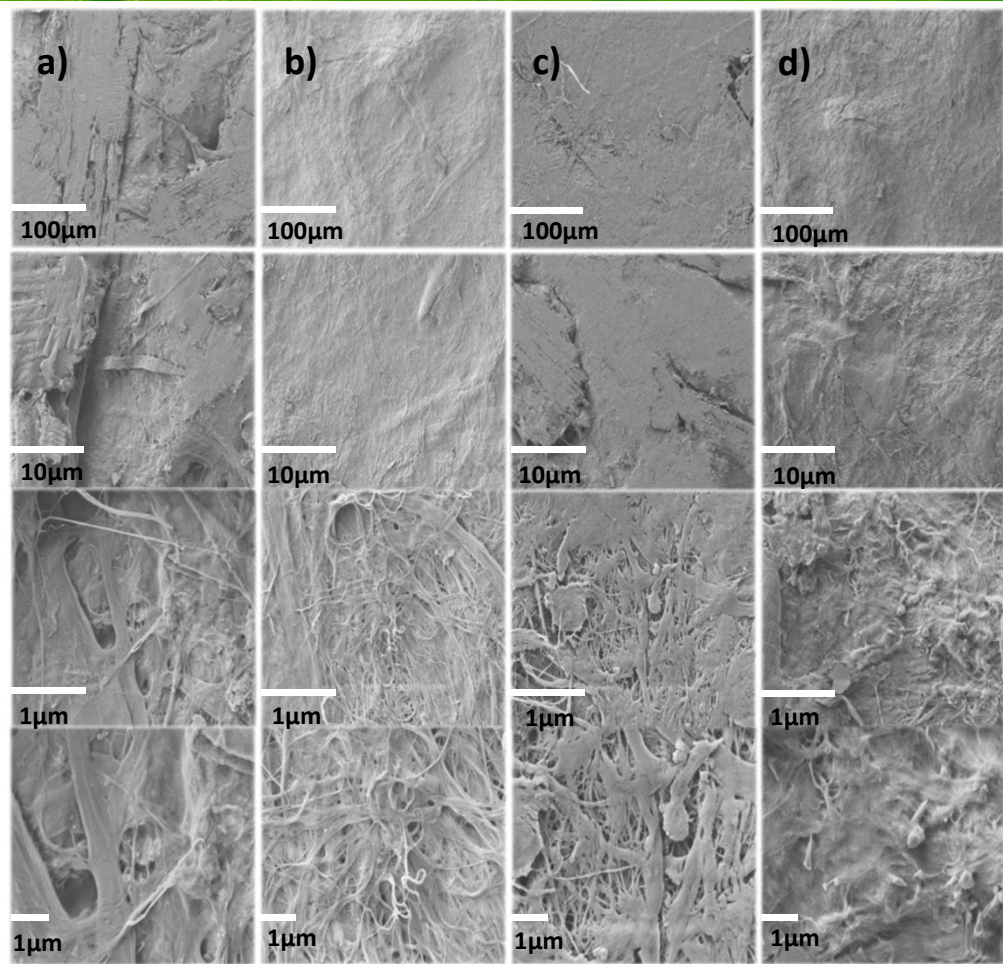
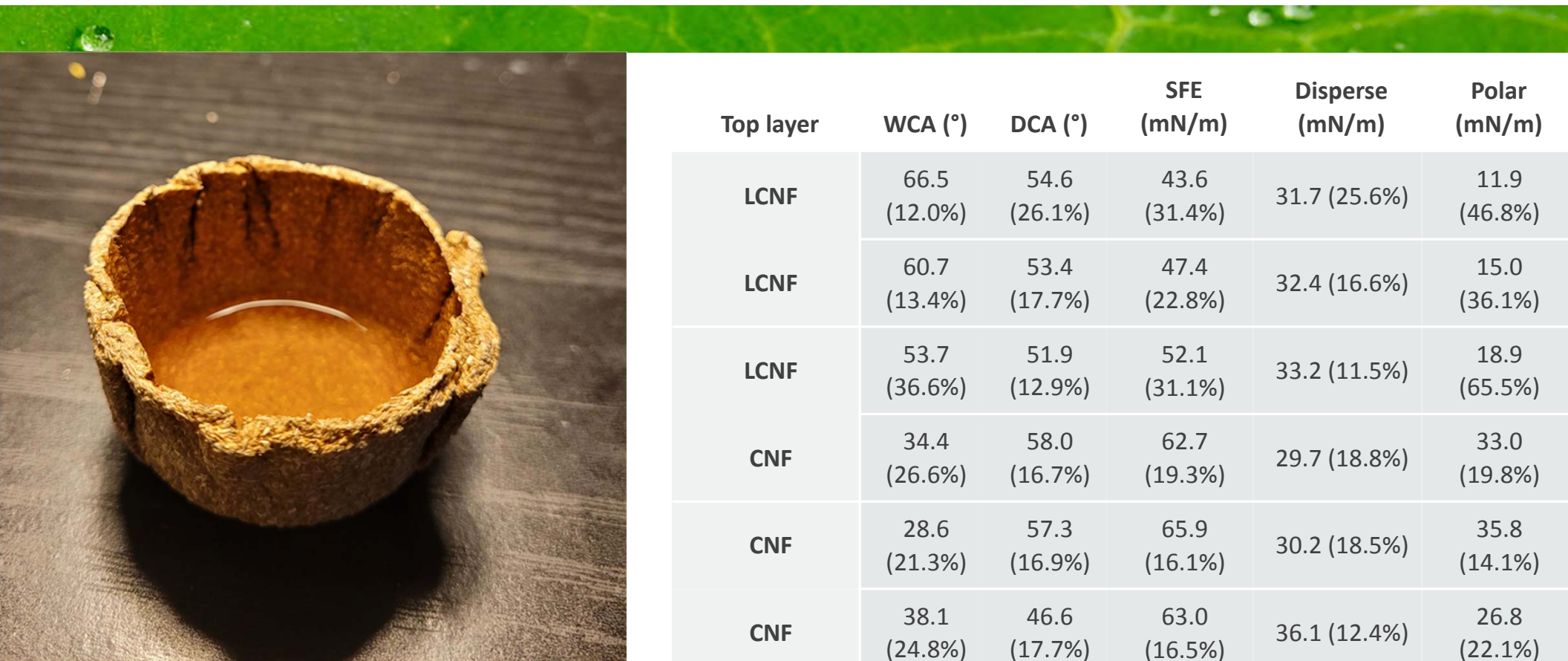


Fig: Surface SEM images of a) uncoated composite material b) coated composite material with LCNF, c) uncoated composite material and d) coated composite material with CNF at top at different magnifications.



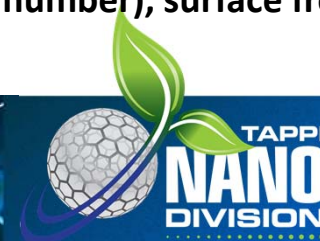
Final product



| Top layer | WCA (°)         | DCA (°)         | SFE (mN/m)      | Disperse (mN/m) | Polar (mN/m)    |
|-----------|-----------------|-----------------|-----------------|-----------------|-----------------|
| LCNF      | 66.5<br>(12.0%) | 54.6<br>(26.1%) | 43.6<br>(31.4%) | 31.7 (25.6%)    | 11.9<br>(46.8%) |
| LCNF      | 60.7<br>(13.4%) | 53.4<br>(17.7%) | 47.4<br>(22.8%) | 32.4 (16.6%)    | 15.0<br>(36.1%) |
| LCNF      | 53.7<br>(36.6%) | 51.9<br>(12.9%) | 52.1<br>(31.1%) | 33.2 (11.5%)    | 18.9<br>(65.5%) |
| CNF       | 34.4<br>(26.6%) | 58.0<br>(16.7%) | 62.7<br>(19.3%) | 29.7 (18.8%)    | 33.0<br>(19.8%) |
| CNF       | 28.6<br>(21.3%) | 57.3<br>(16.9%) | 65.9<br>(16.1%) | 30.2 (18.5%)    | 35.8<br>(14.1%) |
| CNF       | 38.1<br>(24.8%) | 46.6<br>(17.7%) | 63.0<br>(16.5%) | 36.1 (12.4%)    | 26.8<br>(22.1%) |

- Table: Water contact angles (WCA), diiodomethane contact angle (DCA), grease resistance (Kit number), surface free energy (SFE) and its components for the surface of the produced composite films

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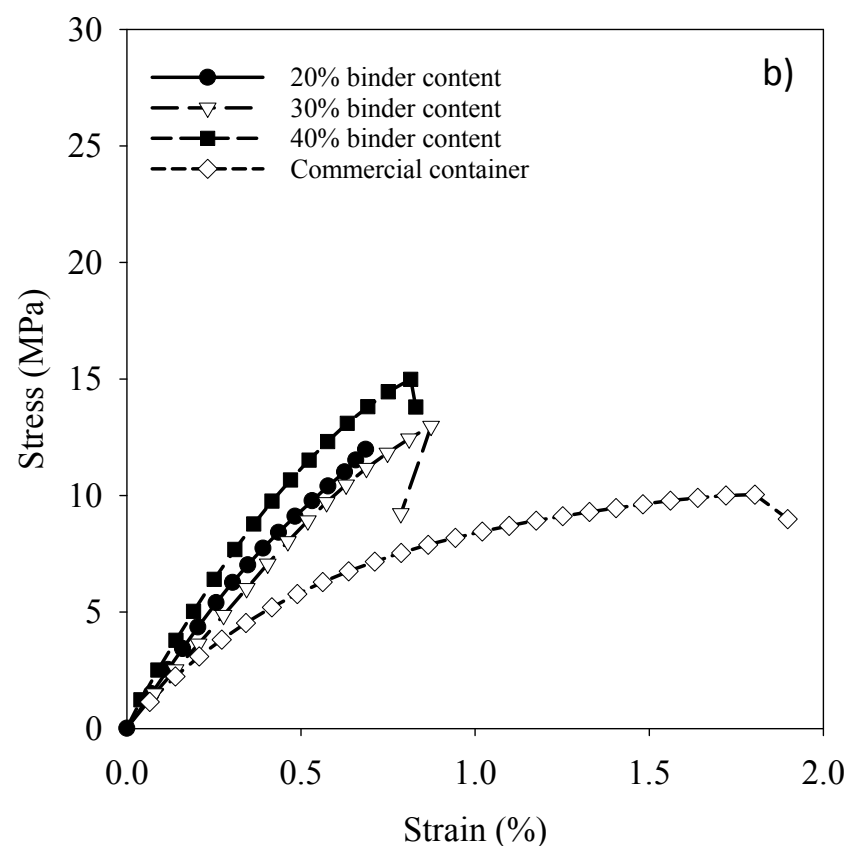
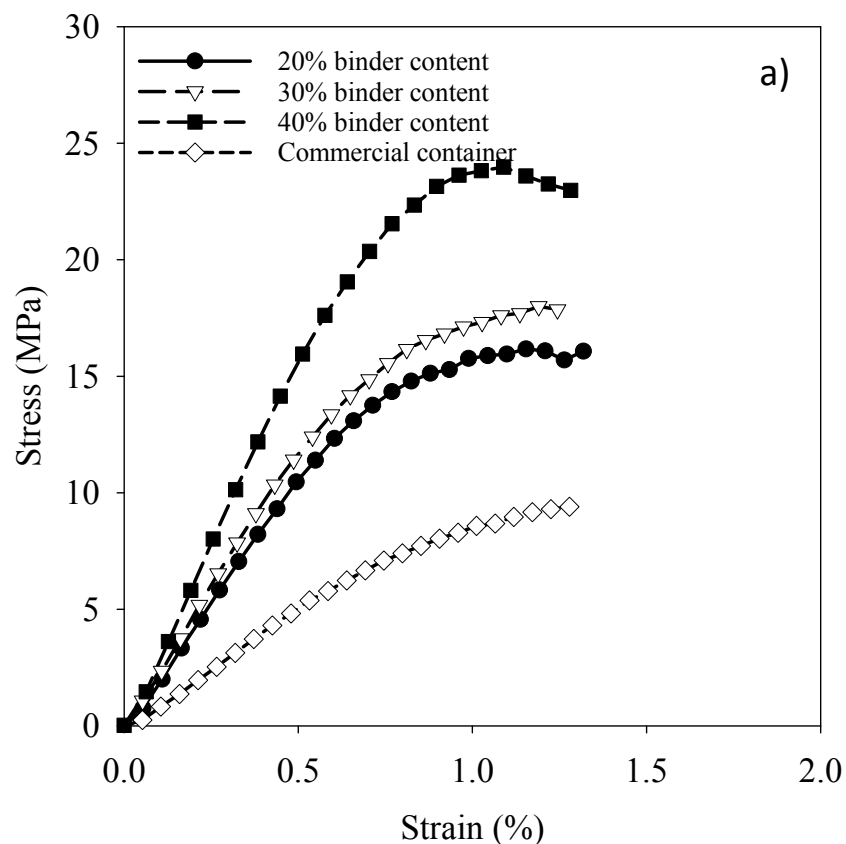


Fig: Representative a) flexural and b) tensile stress-strain curves of the produced composite materials with 70% fine LCNF-OCC at the core at different binder contents compared with the commercial container.



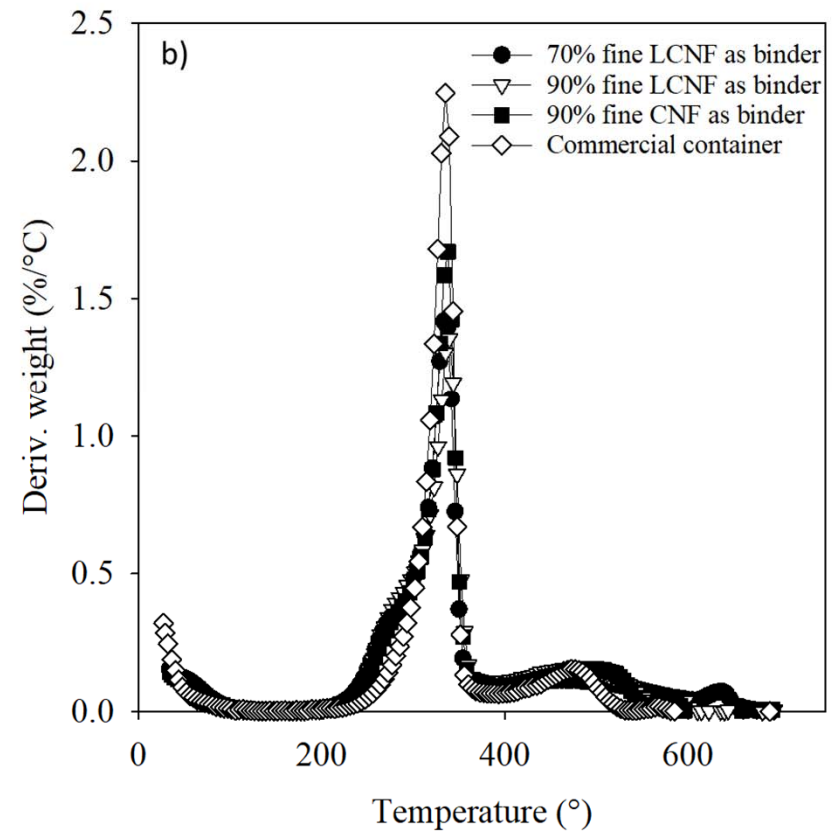
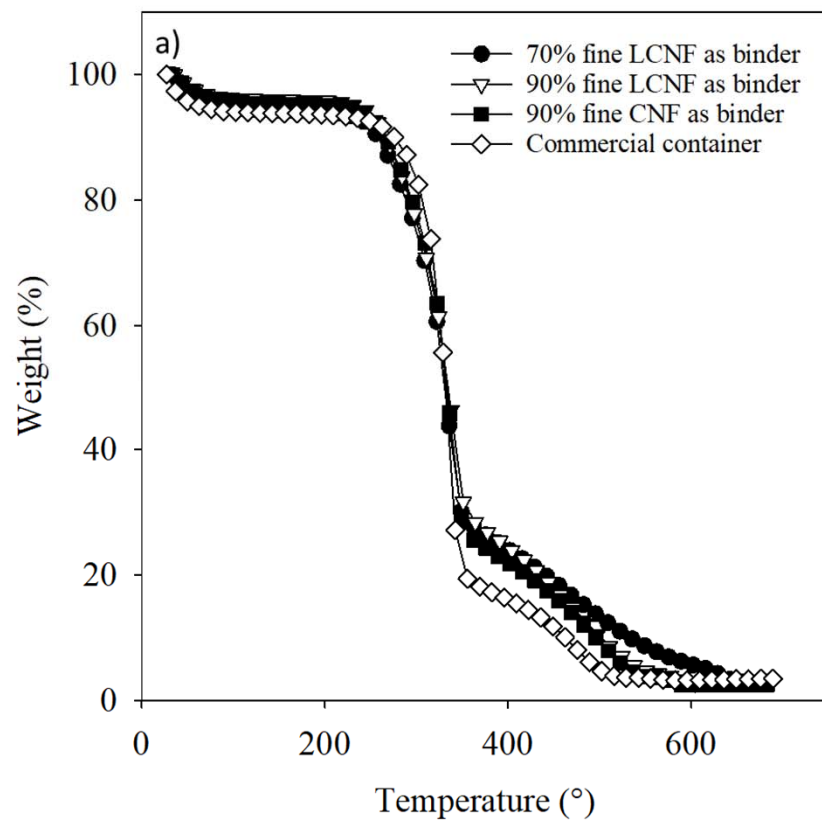
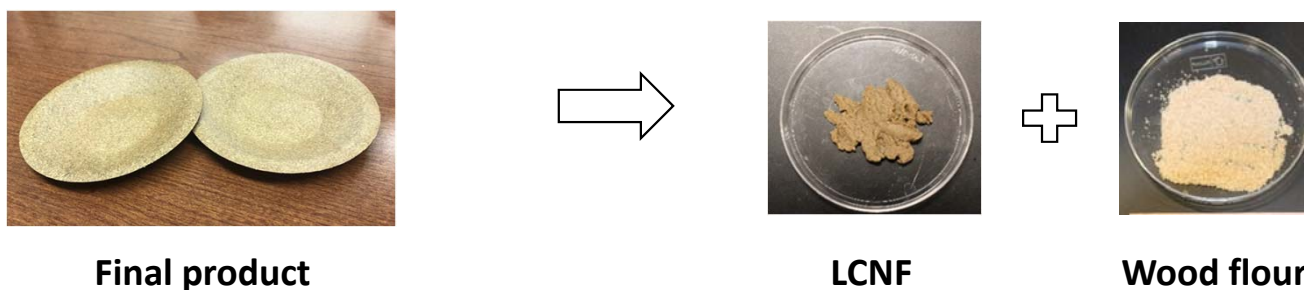
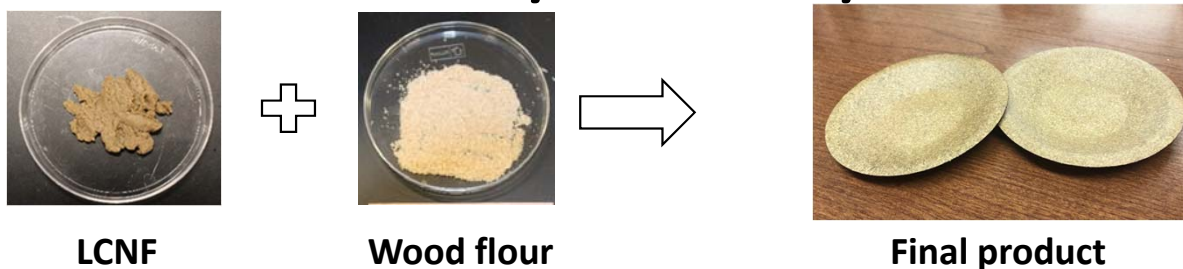


Fig: Typical thermogravimetric analysis of produced nanocellulose composites and commercial plates, and b) the corresponding derivative TG graphs.

# Recyclability



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# Results

Plates with both CNF/LCNF top layer showed excellent grease and oil resistivity

Plates had higher flexural and tensile properties compared to commercial plates

Plates were recyclable



# Acknowledgements



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# Thank you

Any questions or  
suggestions?  
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