



# NewPack

New BioBased Film for Packaging

Liquid-assisted extrusion for bionanocomposite preparation

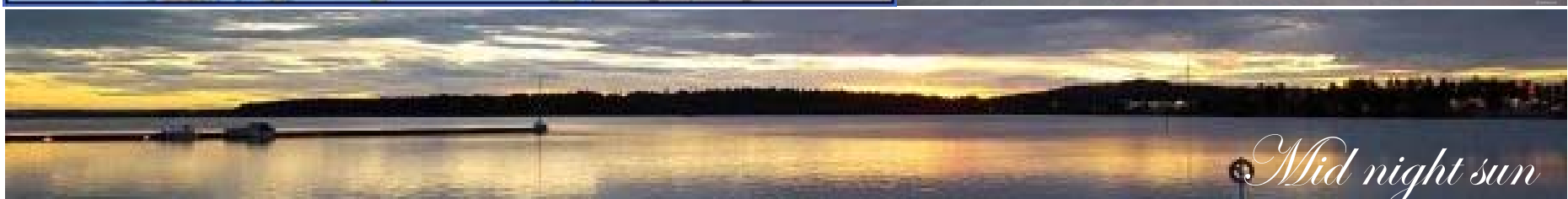
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## Outline

- Background
- Challenges of nanocomposites process
- Introduction of liquid-assisted extrusion process
- The current study: Example of Liquid-assisted extrusion process

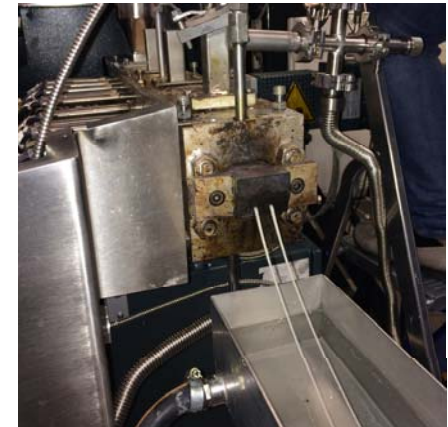
L





## Melt processing of biobased nanocomposites

- The interest to use melt processing have increased very much during the last years
- Most of the studies are focusing on nanocomposites prepared with “micro-extruders” or Brabender with different nanocellulose and polymers
- Some attempts are made in larger scale and using continuous processing
- Attention is also paid on functionalized, coated nanomaterials to enhance their dispersion



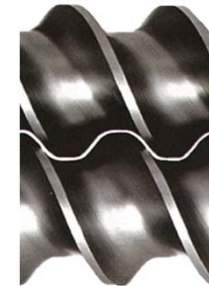


## Twin-screw extrusion

- Is good in mixing and dispersing
- Effective removal of volatiles and moisture
- Flexible screw design
- Fast process, throughput time 30-60 sec



### Conveying elements



Forward &  
backward  
conveying

### Kneading elements



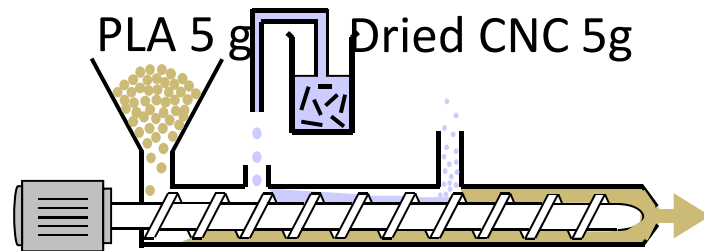
### Tooth mixing elements





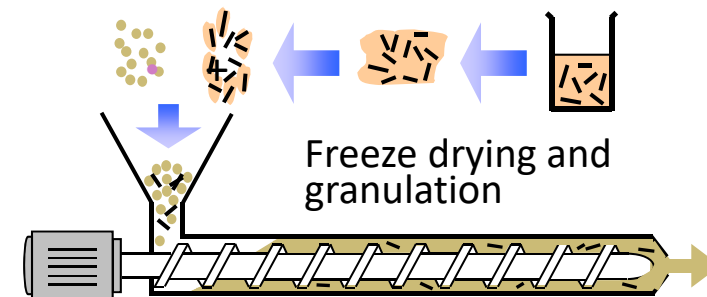
# Feeding of nanomaterials in the extruder is challenging

## Liquid-assisted feeding



## Dry feeding

- Master-batch with high nanocellulose content
- Diluted during extrusion



## Benefits liquid-assisted feeding

- No need to dry the nanomaterials
- Reduced health risk when working with nanomaterials as slurry
- Improved dispersion



## Current study

Polylactic acid reinforced with chitin nanowhiskers via liquid assisted extrusion- Effect of plasticizers on the dispersion of chitin nanocrystals.

## Materials

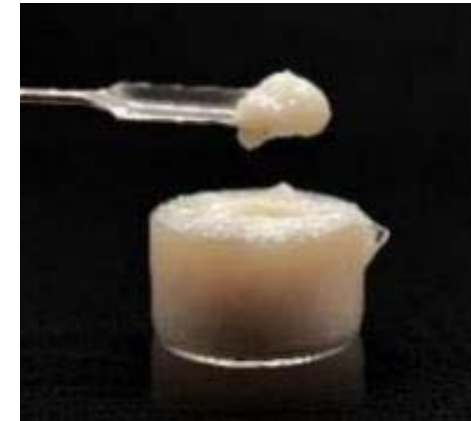
- PLA (Natureworks Ingeo 4043D)
- ChNWs produced from chitin powder

## Suspension preparation

Water in ChNWs : EtOH (1:5) mix with different concentration of Triethyl citrate plasticizer

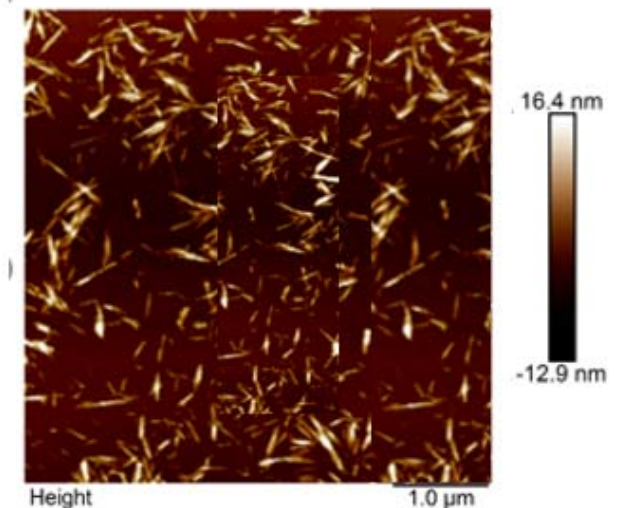
Samples	TEC (wt %)				
	PLA-TEC	0	7.5	10	12.5
PLA-TEC-ChNW*					

\*All nanocomposites were made with 1 wt % ChNW



ChNW (18 %)

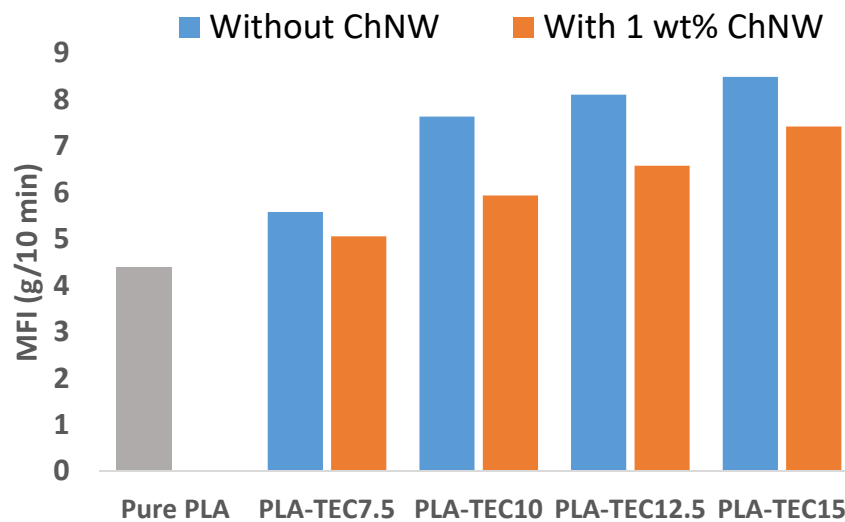
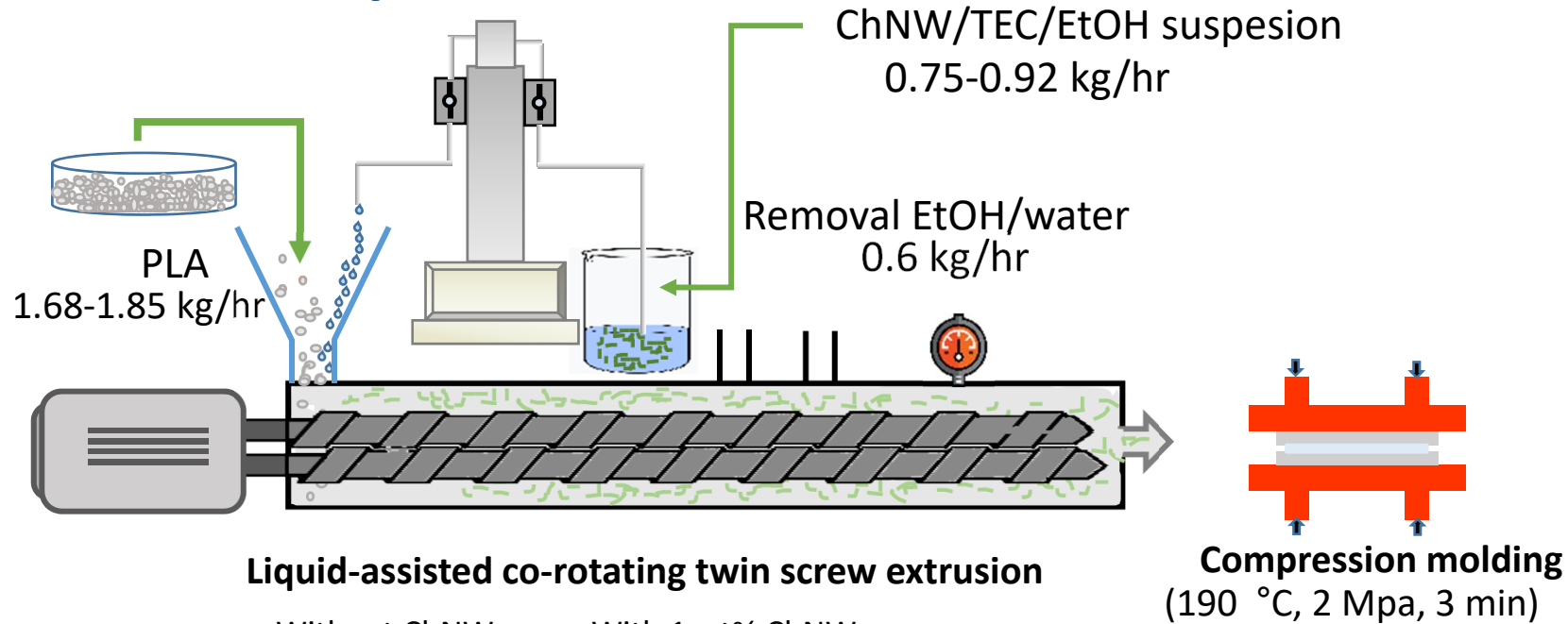
AFM image of ChNW



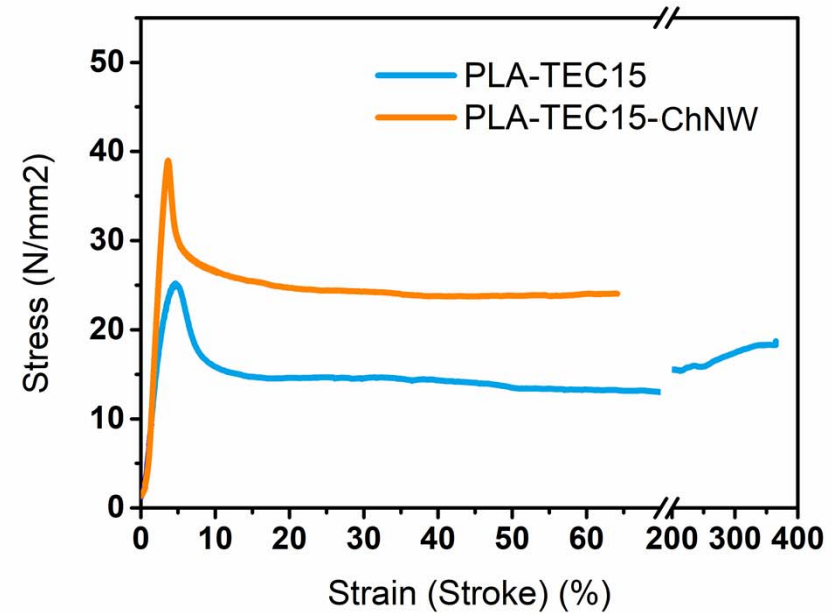
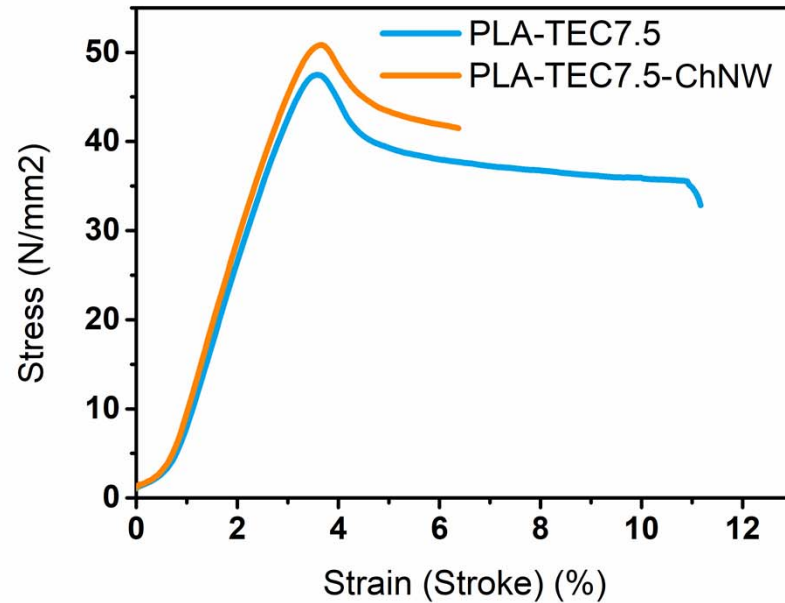
**L :  $279 \pm 82$  nm**

**$\varnothing$  :  $13.8 \pm 3.2$  nm**

# Liquid-assisted extrusion of PLA-ChNW nanocomposites



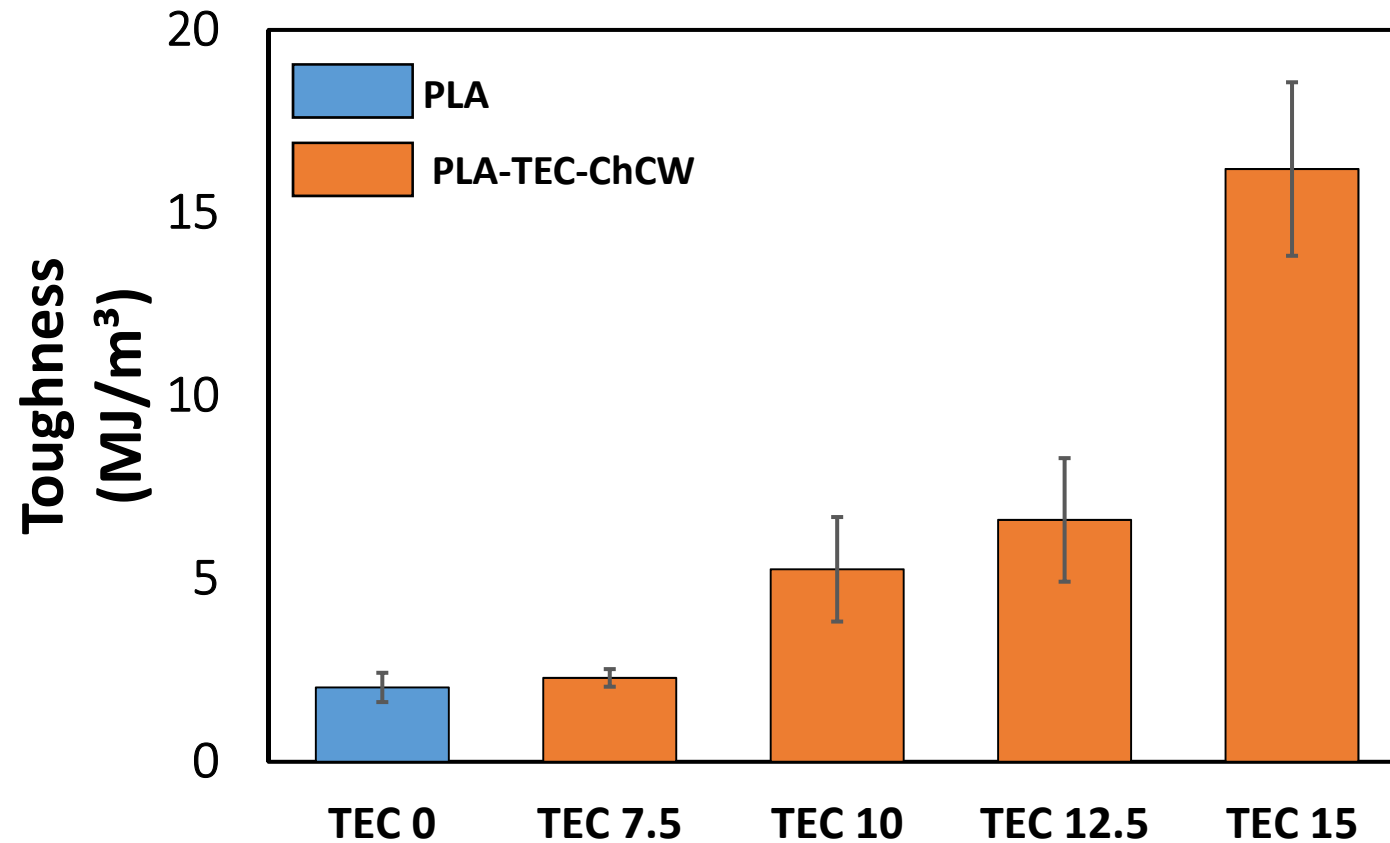
## Mechanical properties



- Addition of ChNWs improve the mechanical properties
- Increasing the TEC concentration increases the elongation at break and decrease the Young's modulus
- Elongation at break is decreased In nanocomposites due to ChNW aggregates

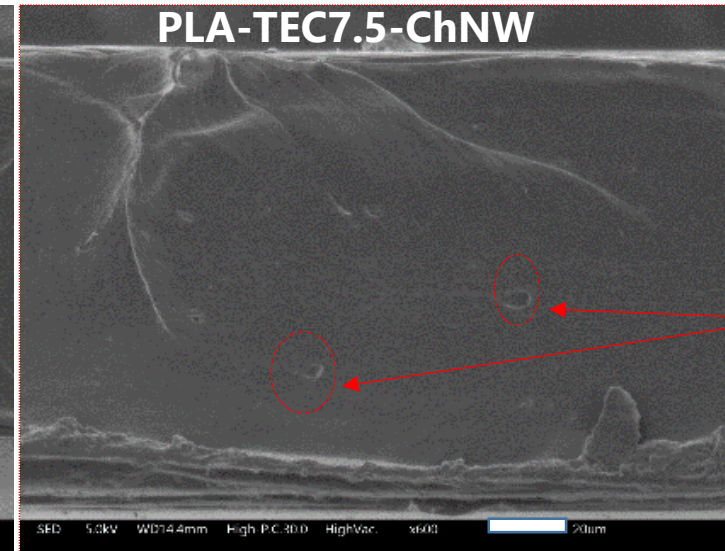
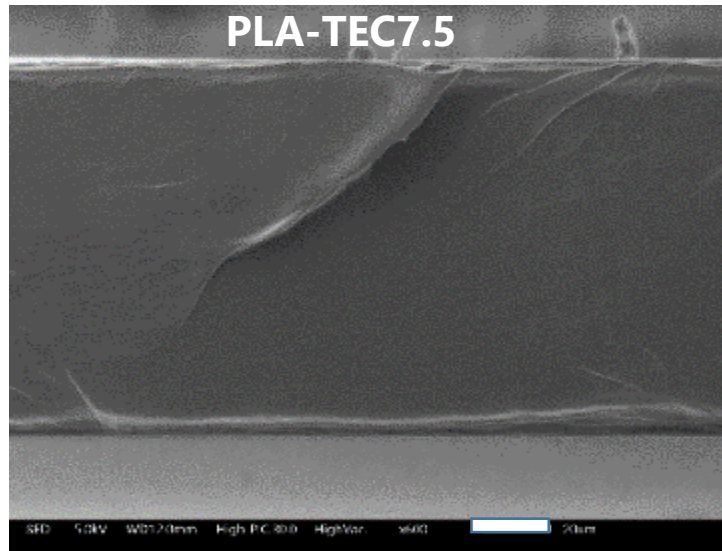


## Mechanical properties

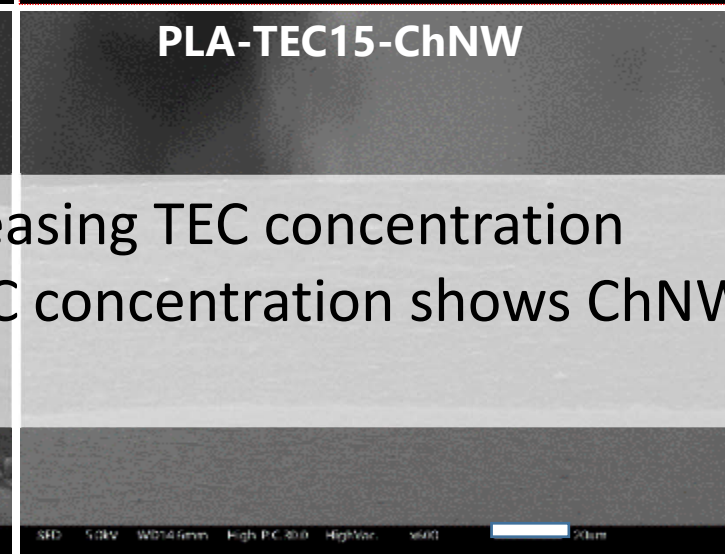
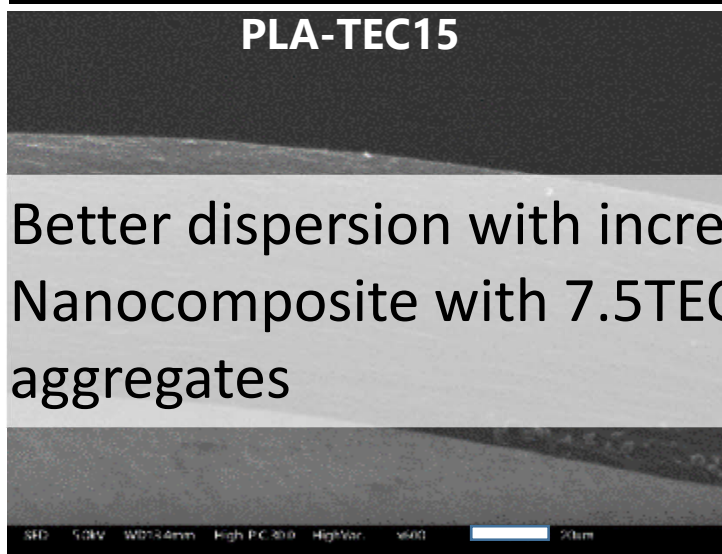


7 times higher toughness than PLA obtained with highest TEC content.

# Microstructure and dispersion



ChNW  
aggregates



- Better dispersion with increasing TEC concentration
- Nanocomposite with 7.5TEC concentration shows ChNW aggregates



## Conclusions

- Better dispersion of nano-reinforcement obtained by liquid-assisted extrusion than conventional extrusion process
- Liquid-assisted extrusion is more simpler, economical and industrial viable process
- With increase amount of plasticizers in liquid-assisted extrusion even, well-dispersed and distributed ChNW in nanocomposites obtained
- Addition of ChNW improves the mechanical properties of the nanocomposites
- Does not affect the transparency of film



# Acknowledgements

We are grateful for the financial support from

