

Properties of bionanocomposites made from poly(lactide) latex and microfibrillated cellulose

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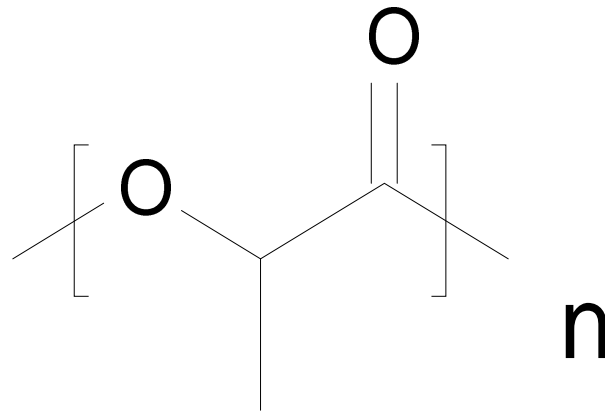
Innventia AB, Stockholm, Sweden



Bio-nanocomposite materials

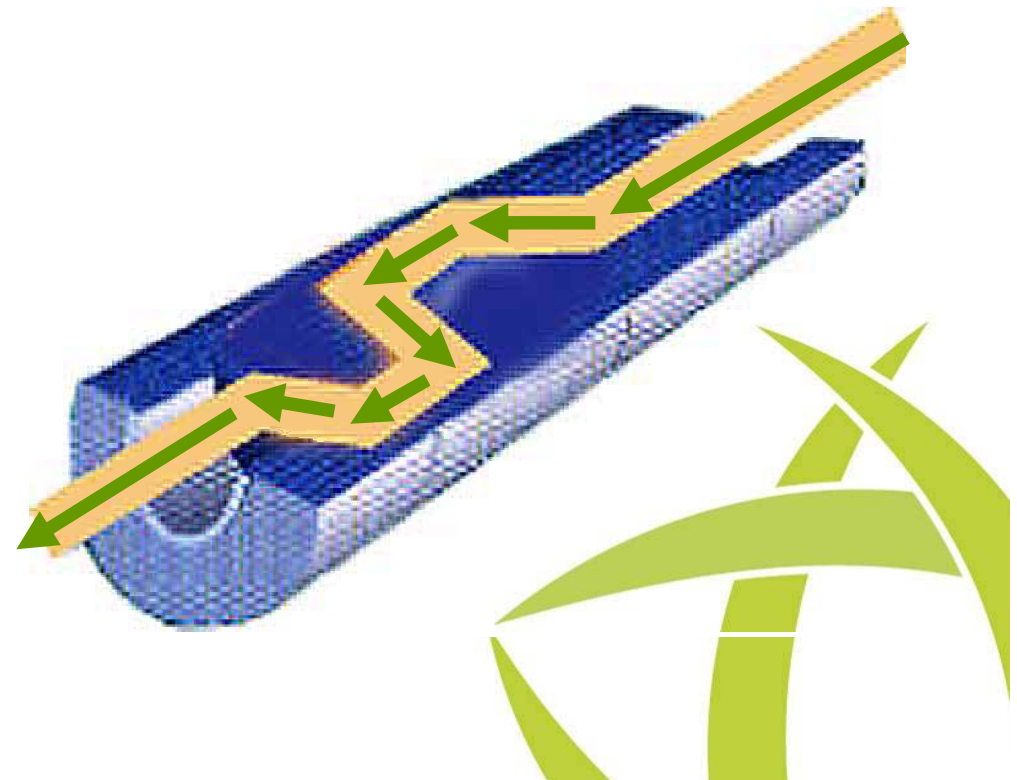
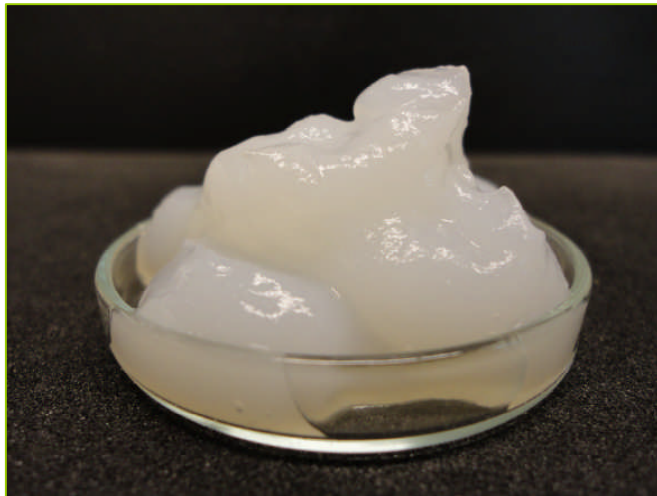
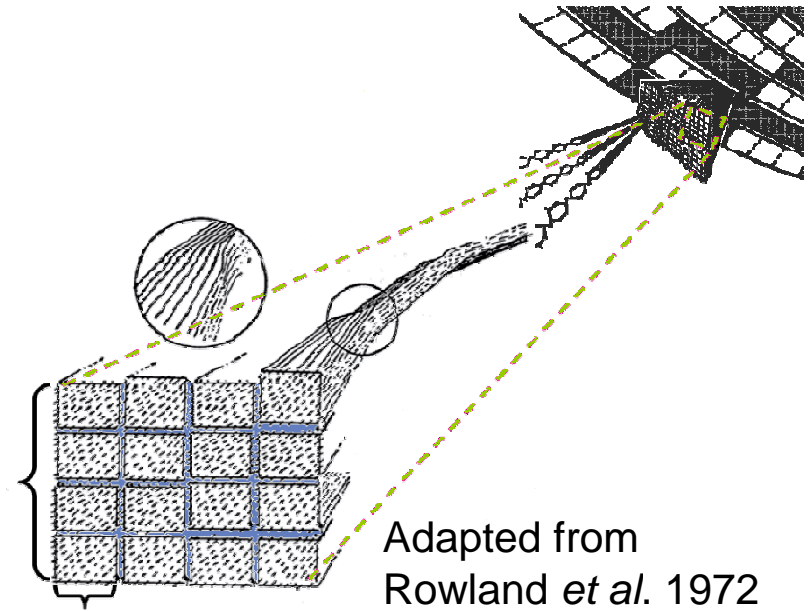
- **poly(lactide), PLA**

- biodegradable, thermoplastic biopolymer
- made from lactic acid produced by fermentation of carbohydrates
- produced by ring opening polymerization of lactide
- solubility – only organic solvents



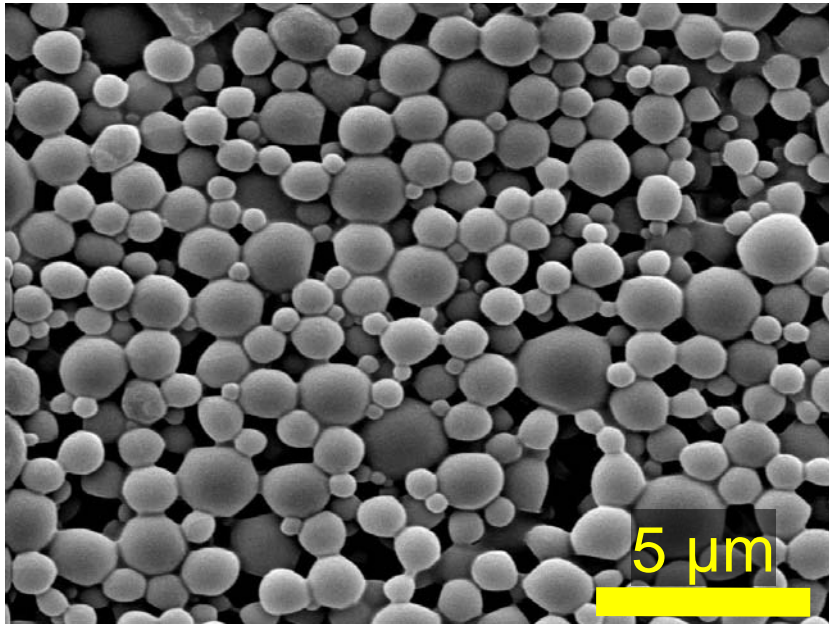
Bio-nanocomposite materials

- **MFC, microfibrillated cellulose (nanocellulose)**
 - Enzymatic pre-treatment of wood pulp
 - Fibre delamination using a high pressure homogenizer



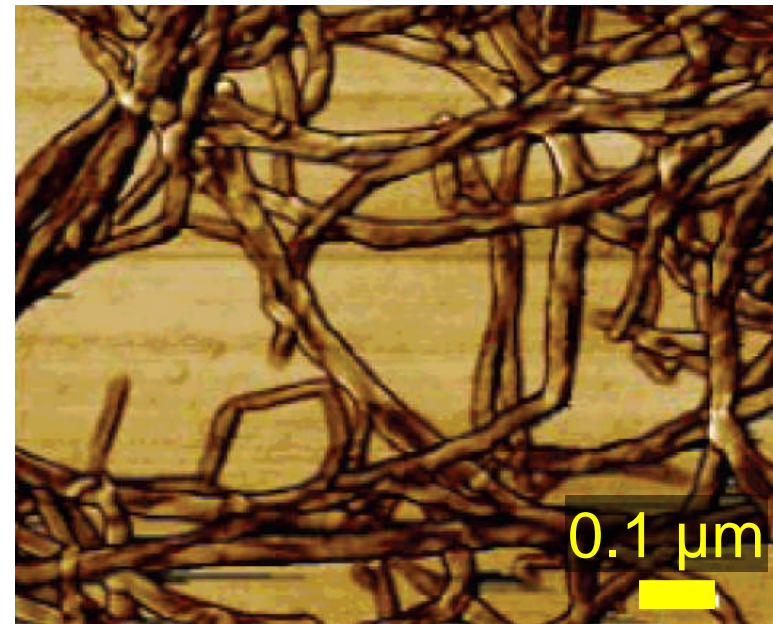
Preparation of bionanocomposites

PLA latex



Courtesy: Joanna Hornatowska,
Innventia AB

MFC



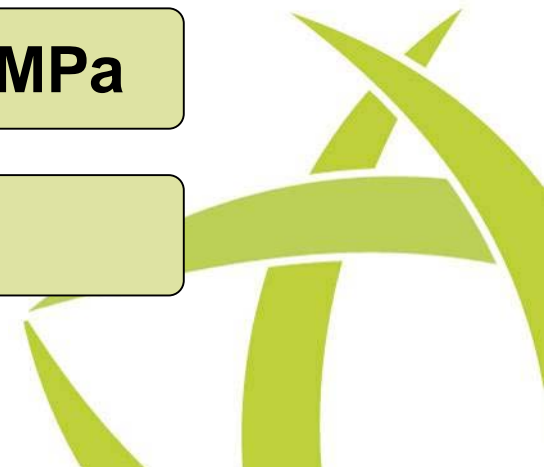
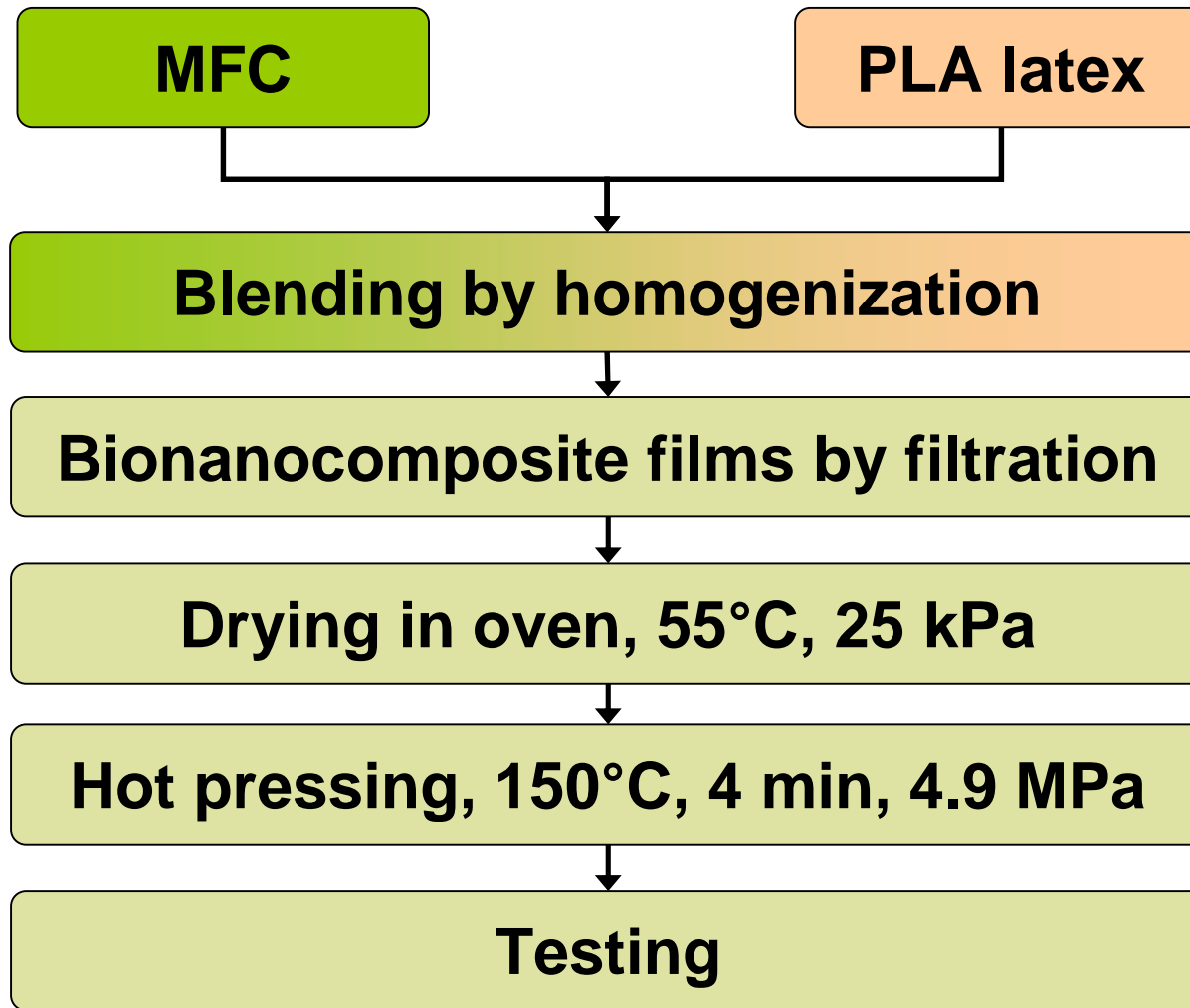
Pääkkö *et al.* *Biomacromolecules* 8(6):
1934-1941 (2007)



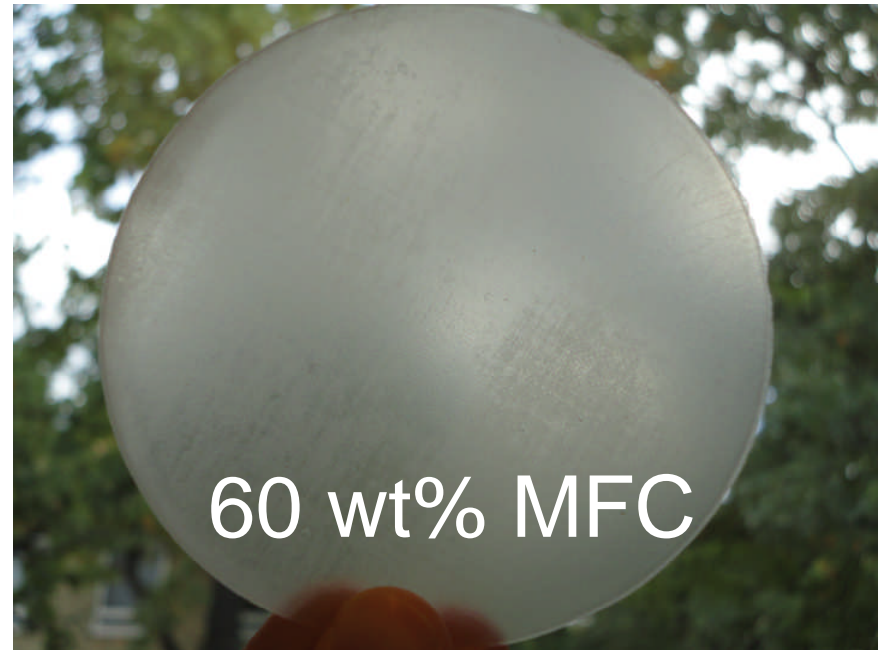
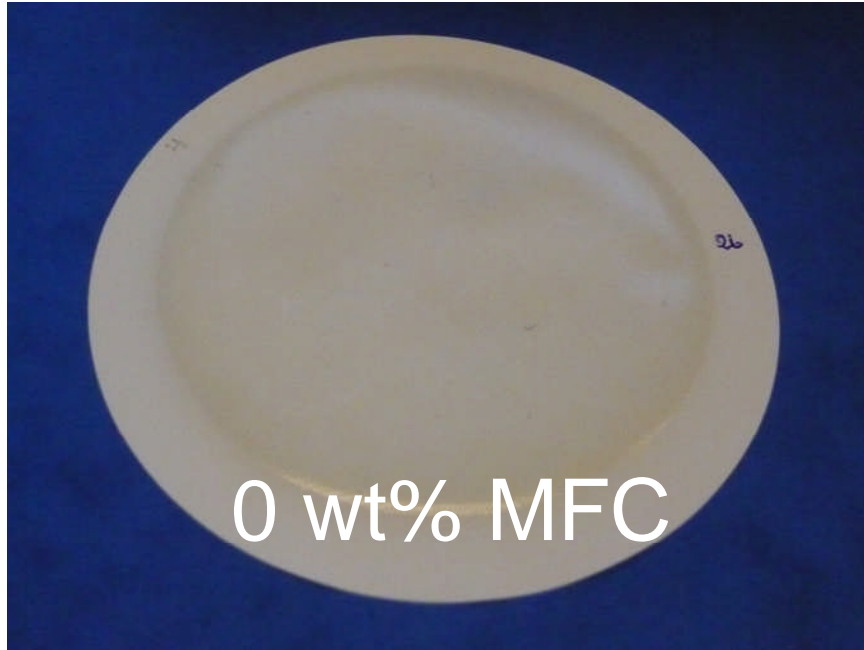
Bionanocomposite material



Preparation of bionanocomposites



Preparation of bionanocomposites



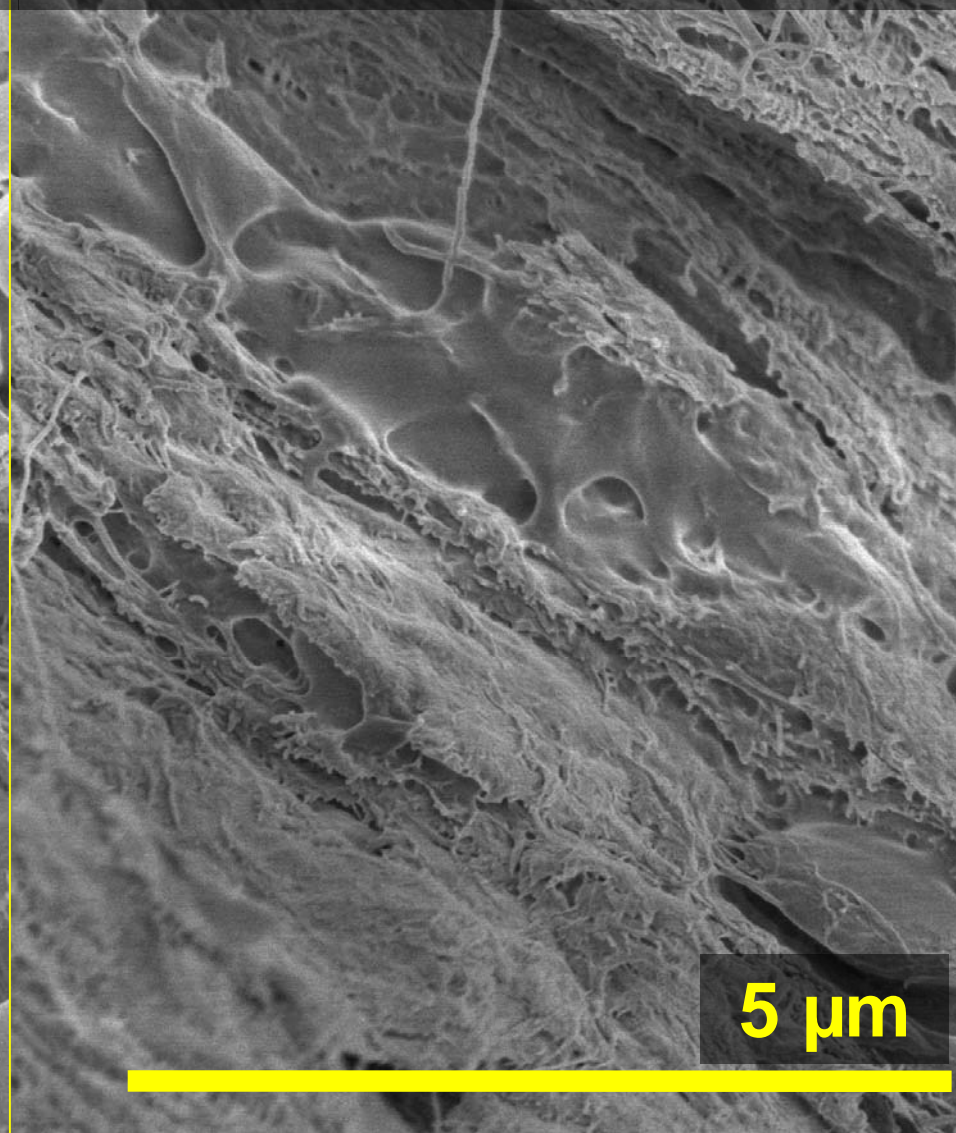
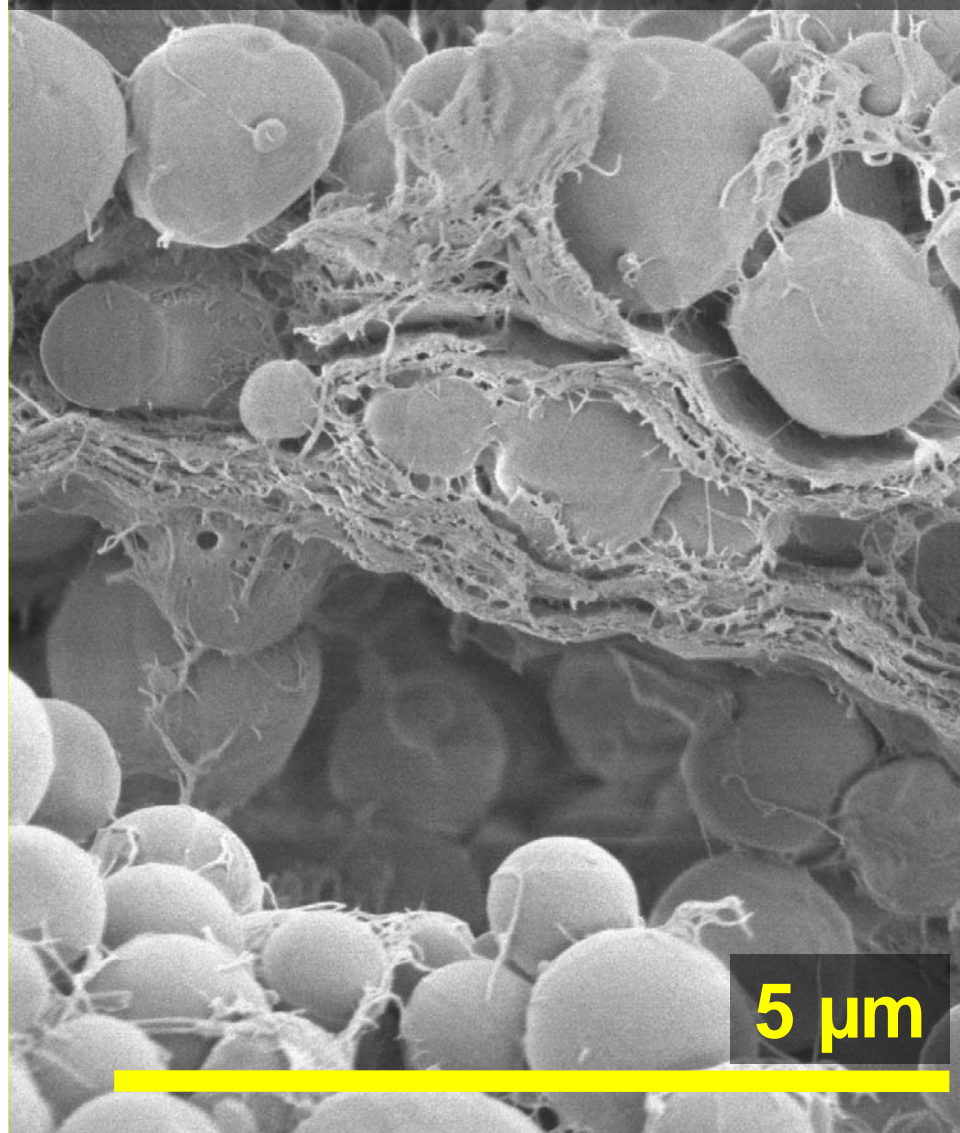
- MFC content 0 - 20 wt% → fragile, hot pressed on filter paper
- MFC content 20 – 100 wt%, free films



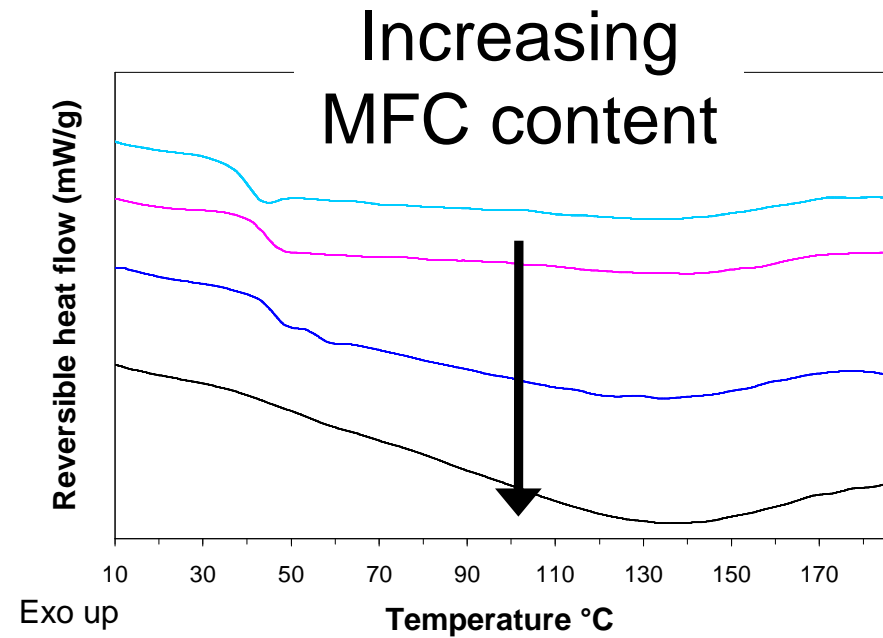
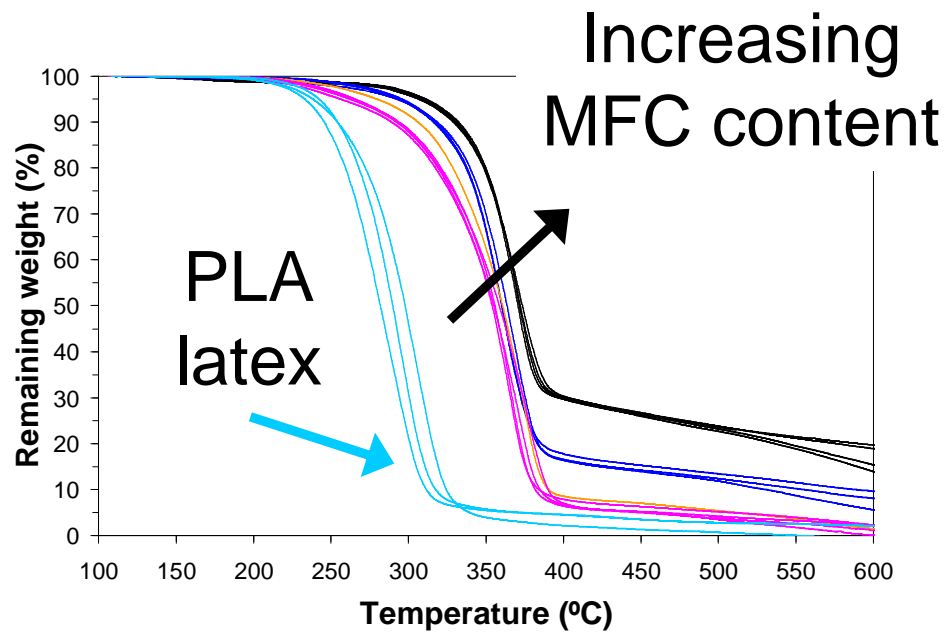
Fracture surface, films with 60 wt% MFC

dried at room temperature

oven dried then hot pressed at 150°C



Thermal properties – TGA and DSC



Increased thermal stability
with increased MFC content

T_g at ~ 45 °C

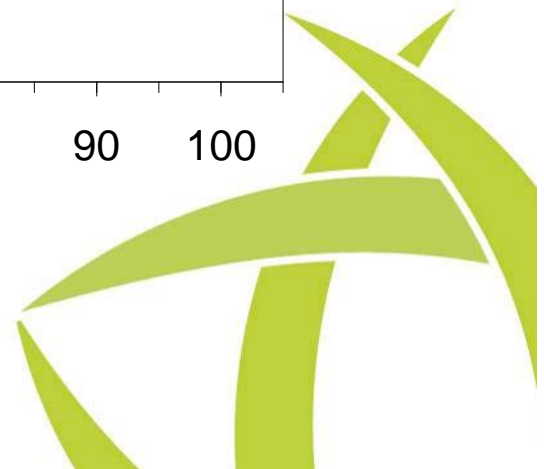
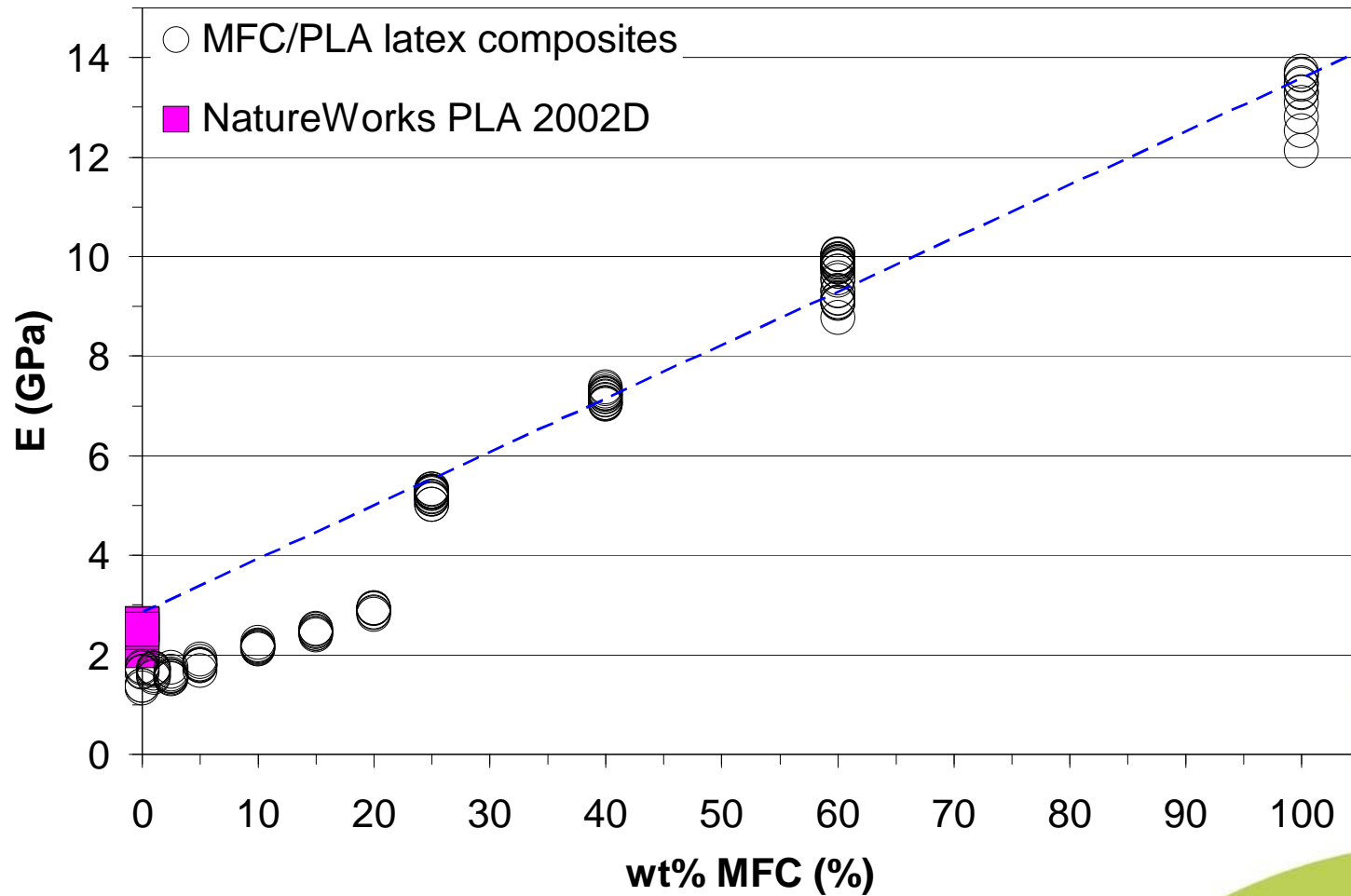


Mechanical properties

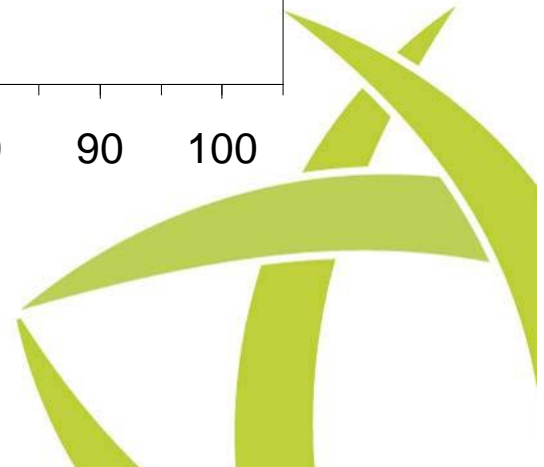
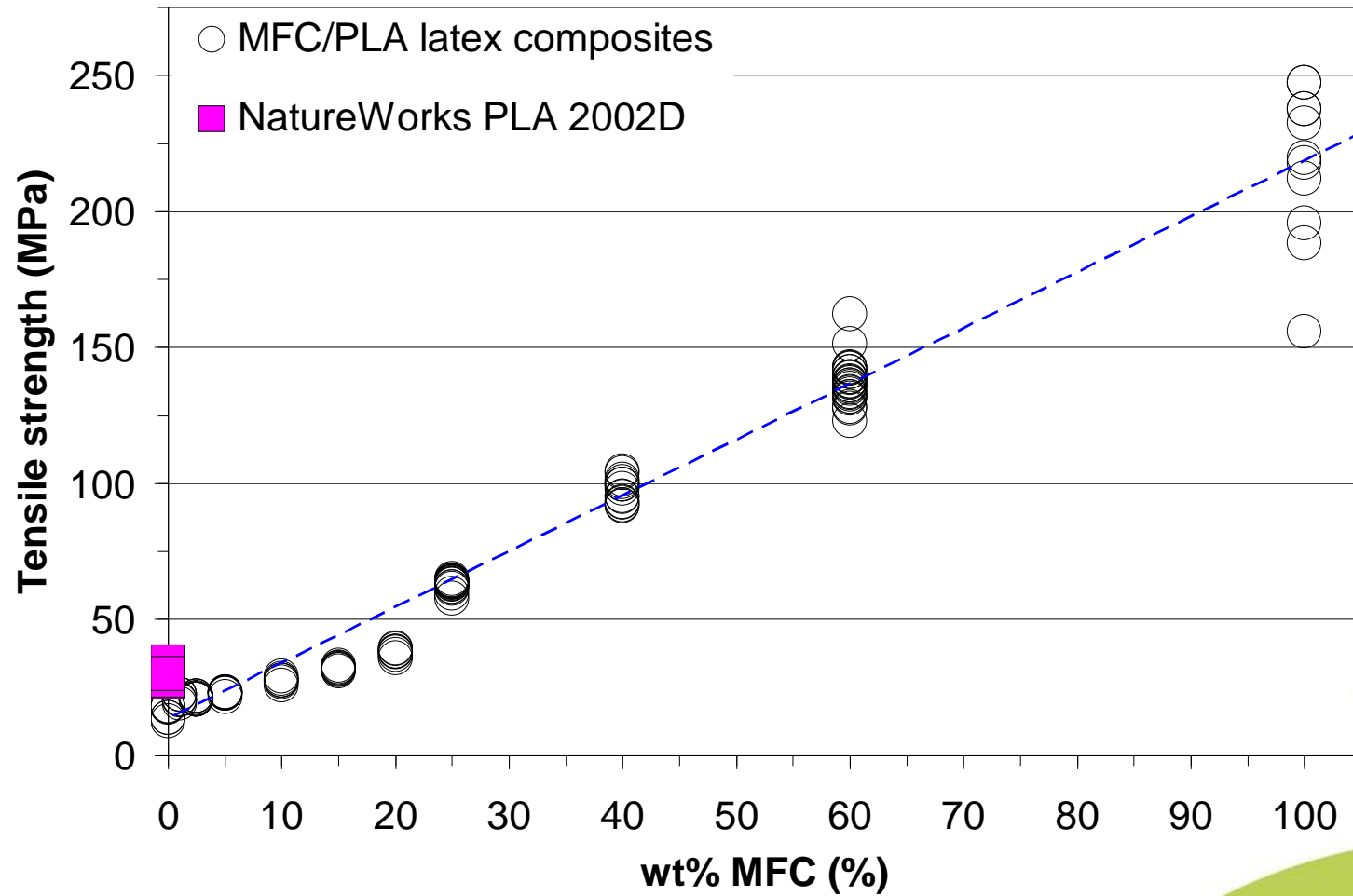
- Tensile test
- Fracture toughness
- DMA



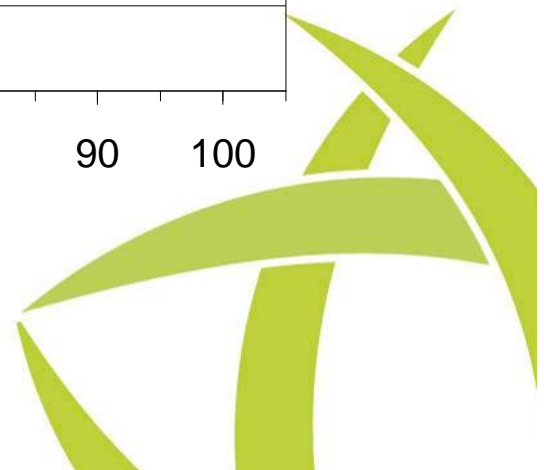
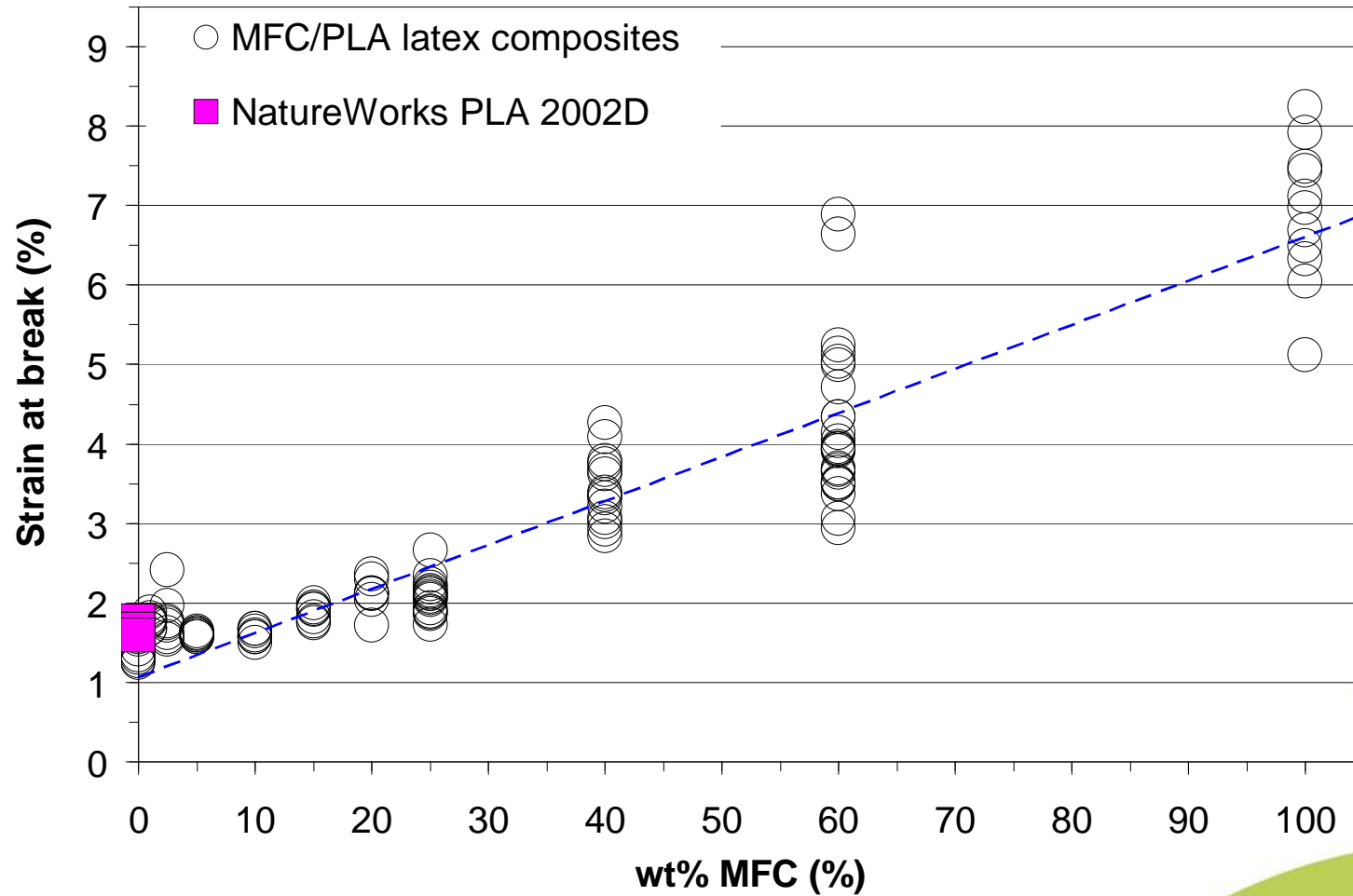
Young's modulus



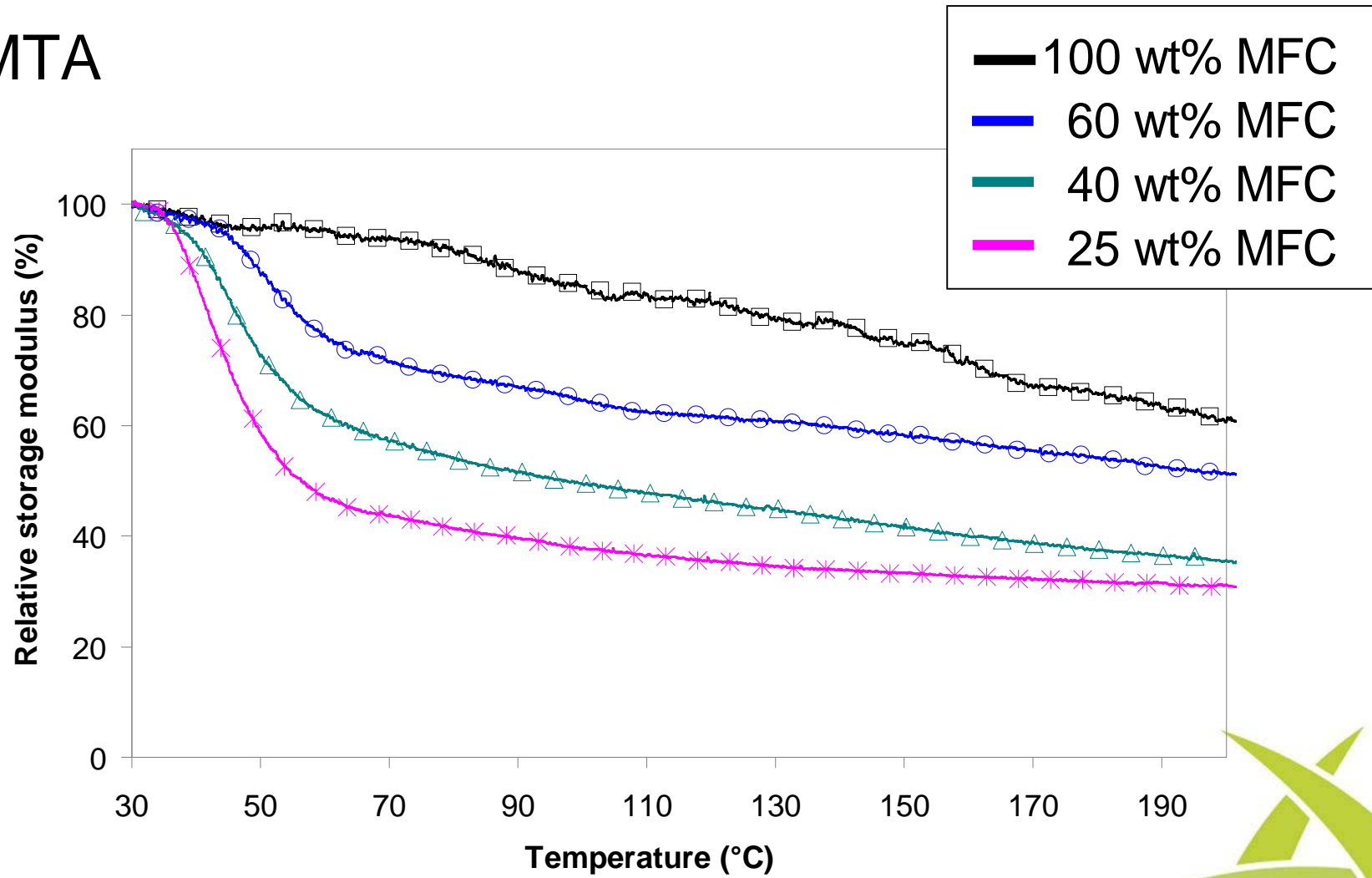
Tensile strength



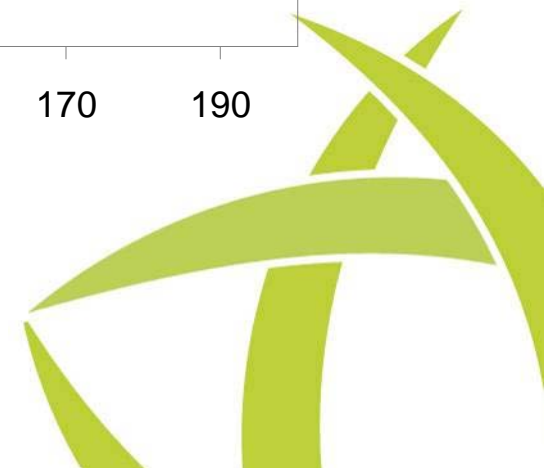
Strain at break



DMTA

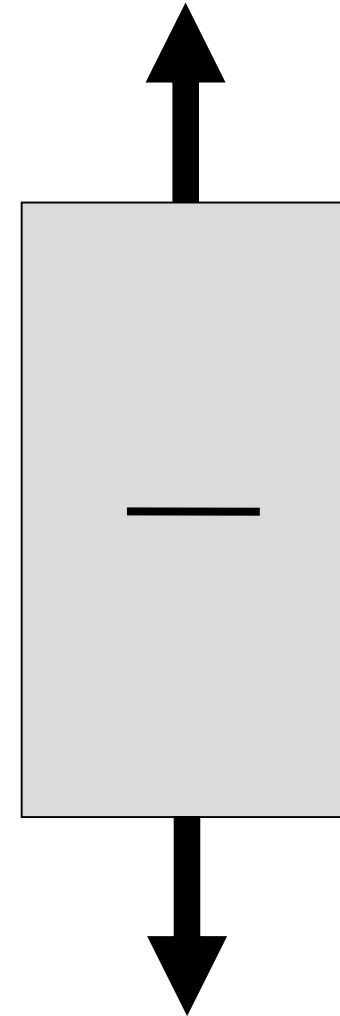


mean curves based on two measurements

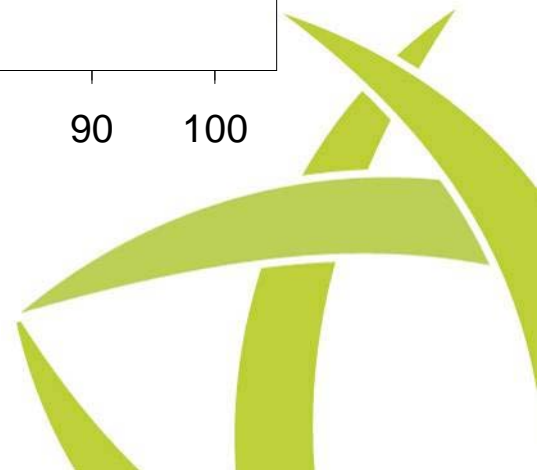
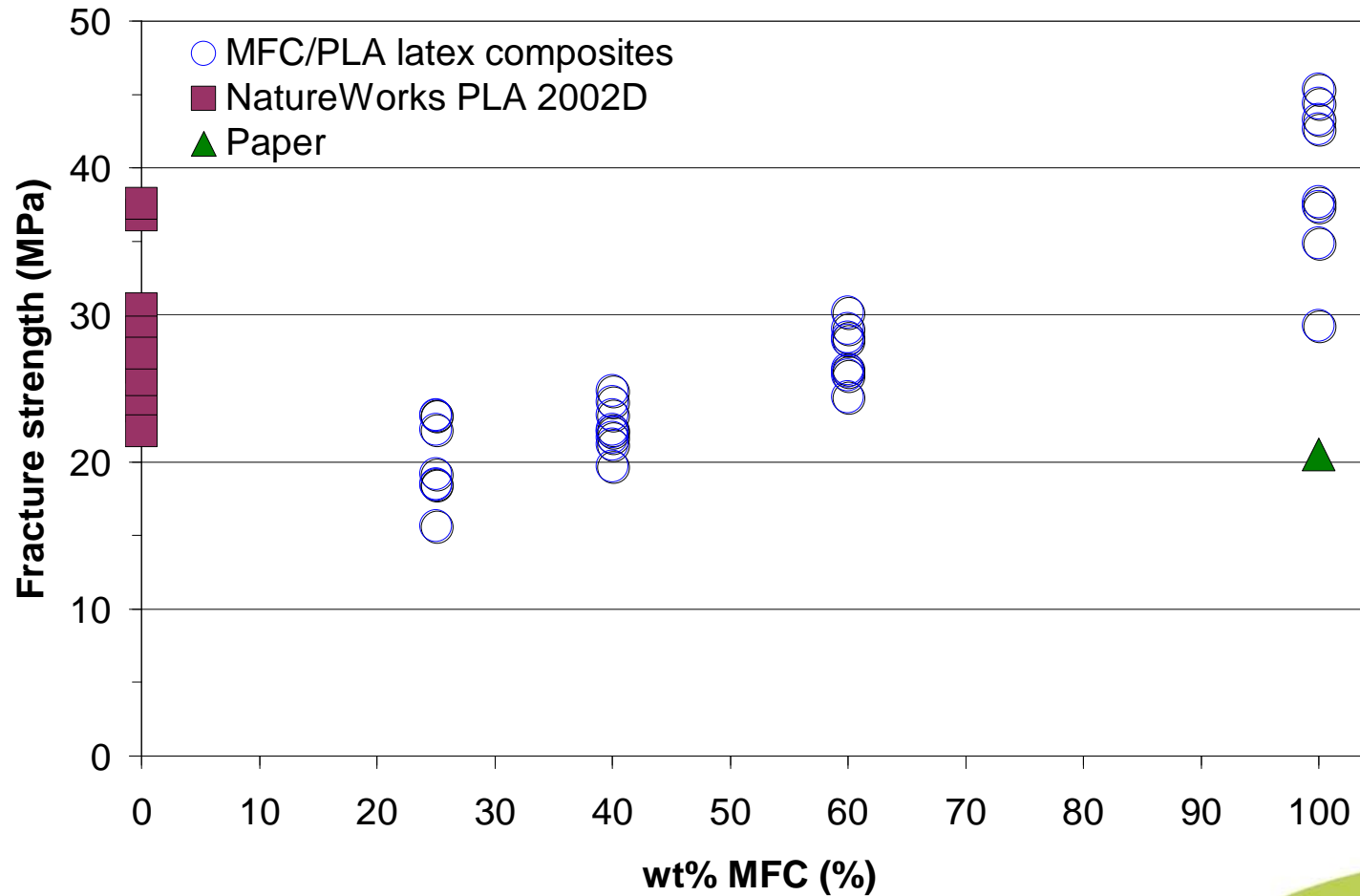


Fracture toughness

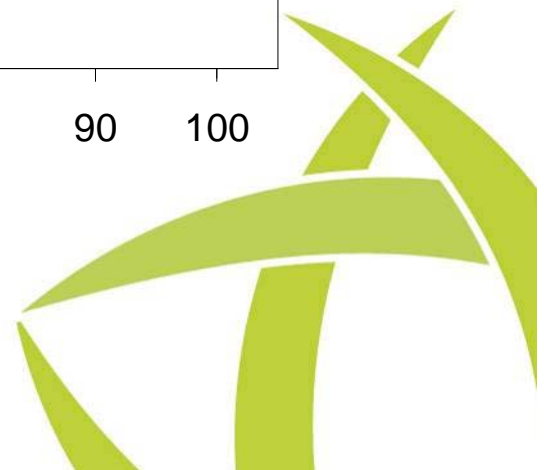
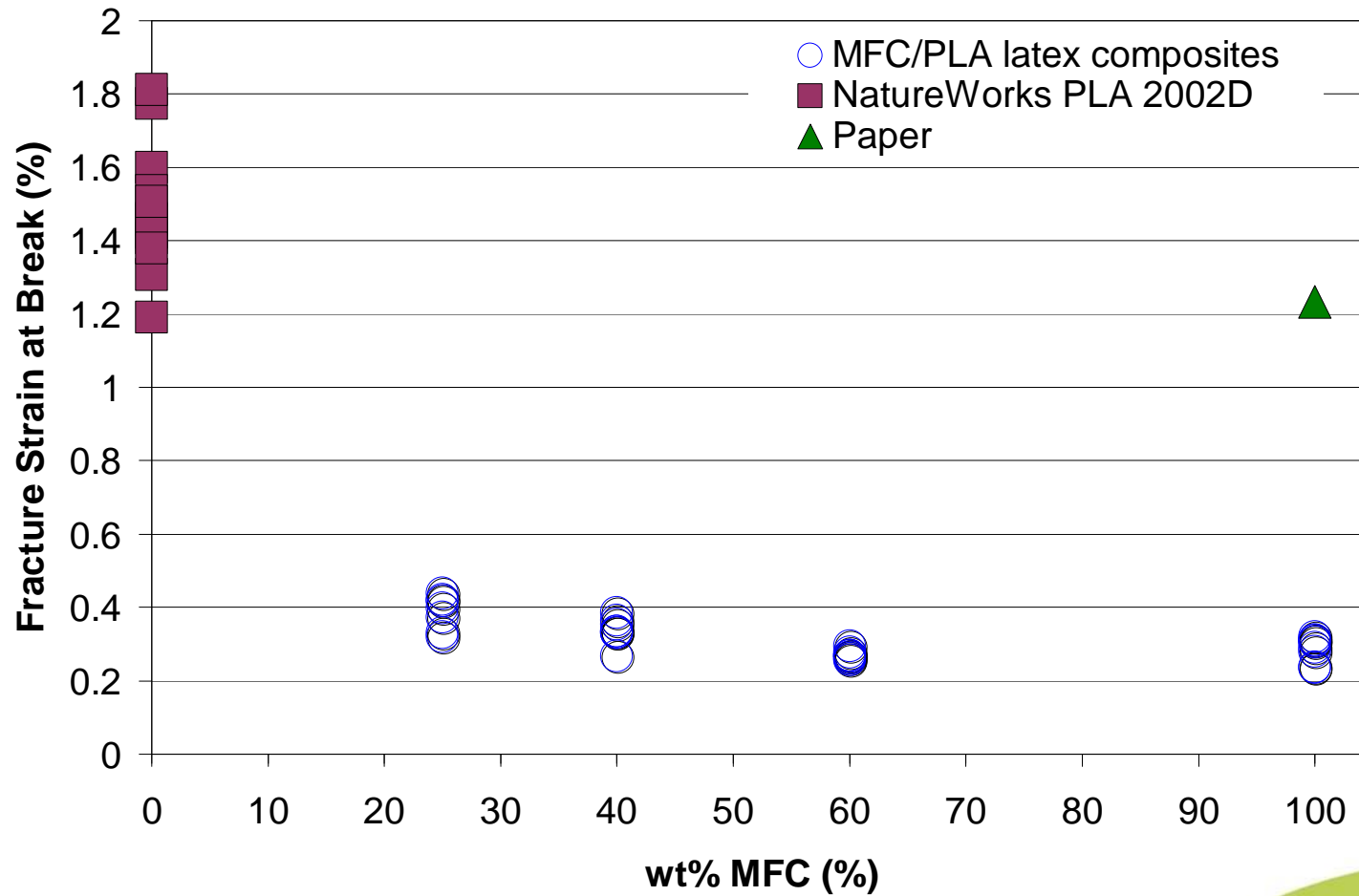
- The bionanocomposite materials ability to sustain defects
- A sharp defect, notch, is introduced in the test sample
- The notched sample is strained to break



Fracture - strength



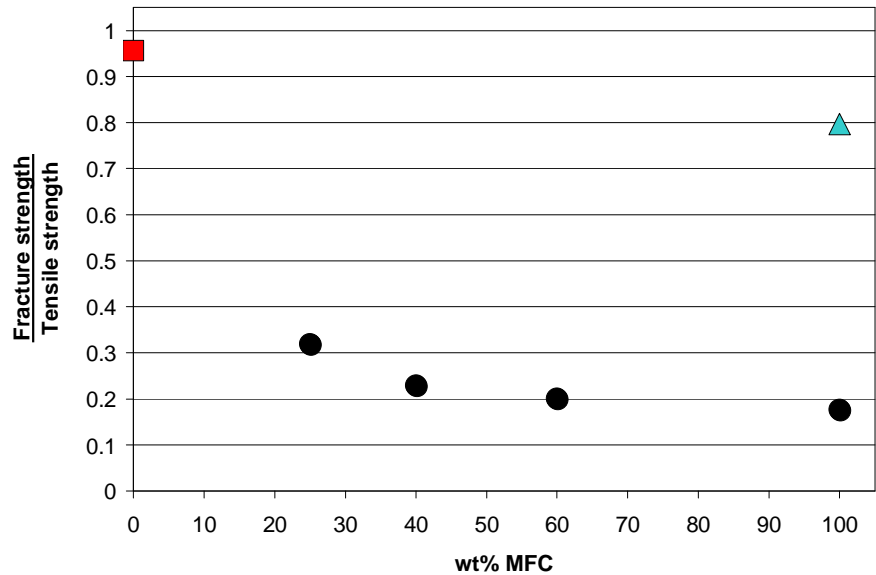
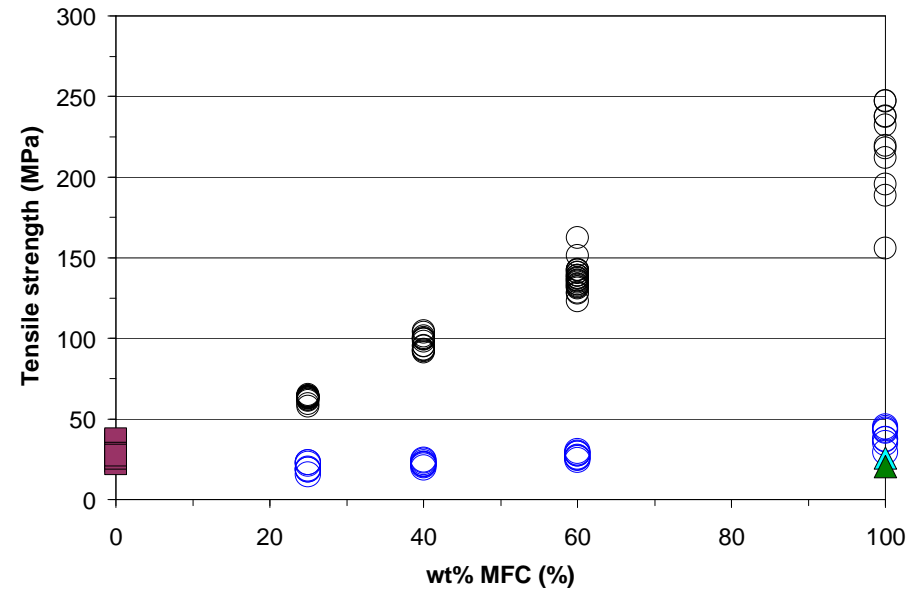
Fracture – strain at break



Fracture analysis

- Tensile strength, MFC/PLA latex composites
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- Tensile strength, NatureWorks PLA 2002D
- Fracture strength, NatureWorks PLA 2002D
- ▲ Tensile strength, paper
- ▲ Fracture strength, paper

- strength (notched sample) MFC/PLA latex composites
tensile strength
- strength (notched sample) NatureWorks PLA 2002D
tensile strength
- ▲ strength (notched sample) Paper
tensile strength



Conclusions

- Wet-mixing the composite components is a straight-forward technique for obtaining good dispersion of the materials.
- Linear improvement in the tensile properties of the composites with MFC content
 - pure MFC films having a tensile strength of 215 MPa and a Young's modulus of 13 GPa.
 - Tensile yield strength improved from 60 MPa at 25 wt% MFC reinforcement to 137 MPa at 60 wt% MFC.
 - Stiffness increased from ~5 GPa at 25 wt% MFC reinforcement to ~9.5 GPa at 60 wt%.



Acknowledgements

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Thank you for listening!

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