IMPROVED COMPOSITE MATERIALS FOR OCEAN ENERGY DEVICES

September 5th 2023

15th ewtec 2023
European Wave and Tidal Energy Conference Series

Dr. Célia MERCADER

CANOE, FRANCE

mercader@plateforme-canoe.com

www.plateforme-canoe.com

NEMMO
MAKING BLADES BETTER

Nano-enhanced composites development for enhanced fatigue and impact resistance

OBJECTIVES :

- enhance blade material performances
  - improve the fatigue and impact resistance

- Use of nano-particules to reinforce the composite materials

- The blade is made of :
  - RESIN : vinyl ester resin
  - FABRICS : glass fabrics

- DISPERSION of the nano-particules inside the resin before manufacturing the composite blades

NEMMO
MAKING BLADES BETTER

Nano-enhanced composites

Different fillers and different concentration were selected

- Carbon Nanotubes (CNT)
- Impact modifiers

- A true dispersion = homogeneous and stable of the nanoparticles in the resin is required to reinforce the matrix against cohesive failure of the composite
- Use of three rolls mill or cold twin screw extruder (= high shear device) to perform the dispersion at high concentration before dilution by conventional stirring

Commercial pellets (25wt% of CNT inside matrix)

Dispersion of the CNT inside NEMMO resin at 2,5wt% using three rolls mill

NEMMO
MAKING BLADES BETTER

Vaccuum Assisted Resin Infusion process

Conventional method to manufacture blade is INFUSION

Evaluation of the different fillers at different concentrations on infused composite plates

For each fillers and each concentration, 4 plates are infused for characterizations

→ 17 formulations were mechanically characterized

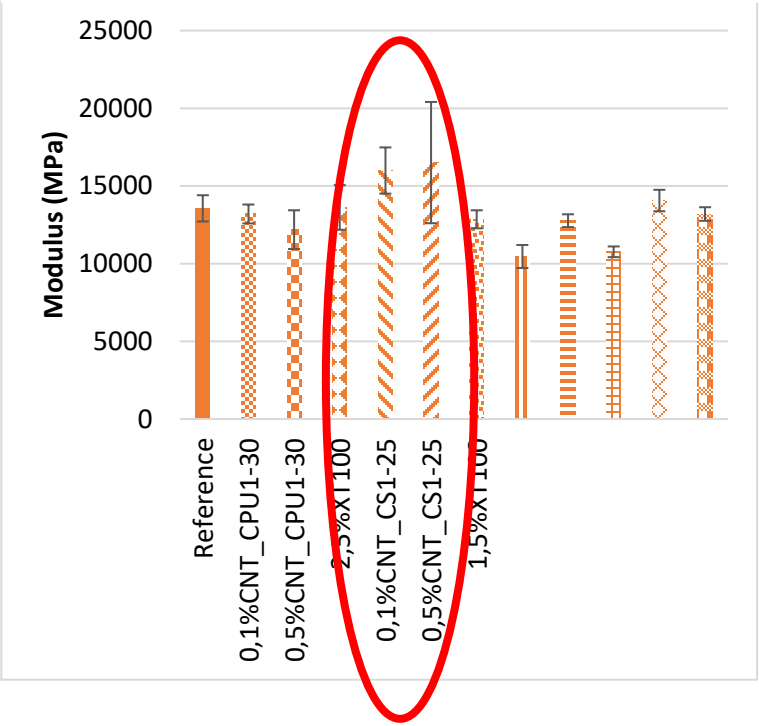
NEMMO
MAKING BLADES BETTER

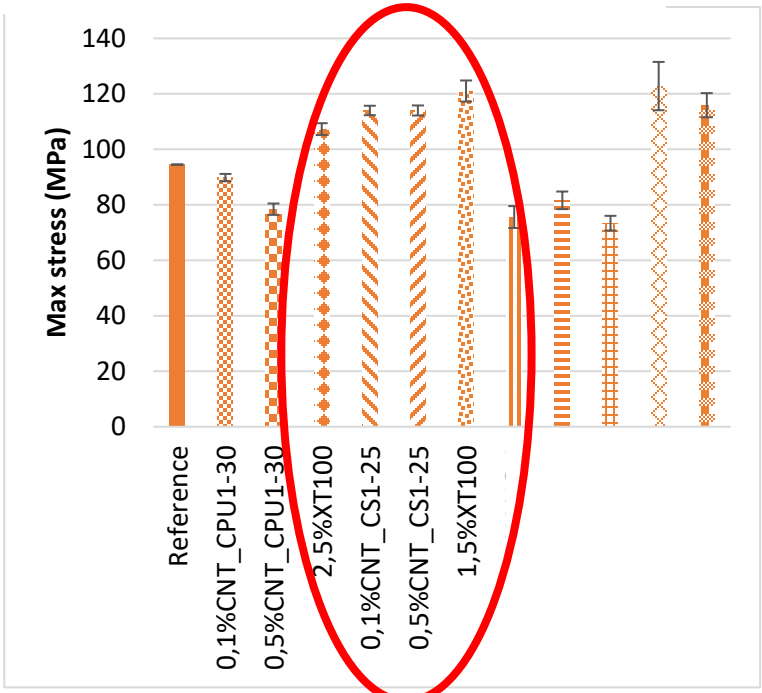
Mechanical characterization of the in-plane laminates properties

Traction with fibers at 0° and 90°

- Mechanical behaviour (Modulus and Maximum stress) in fibers direction and in transverse direction not influenced by the matrix formulation

Traction with fibers at +/-45°

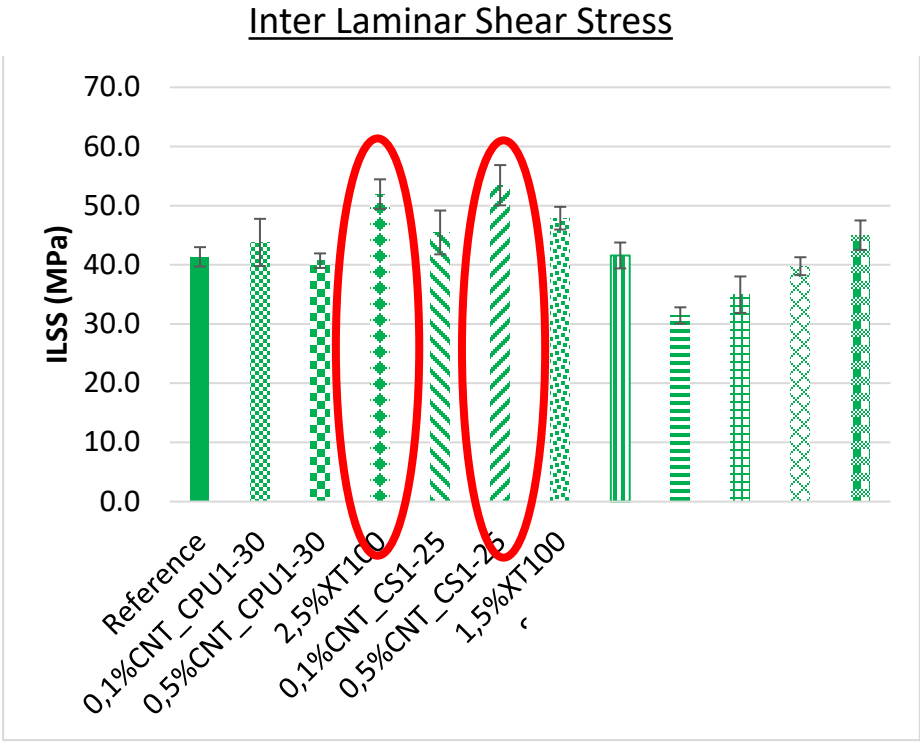




- Best results obtained with XT100 = impact modifier, CNT_CS1-25 (Modulus + Max stress)

IEMMO
KING BLADES BETTER

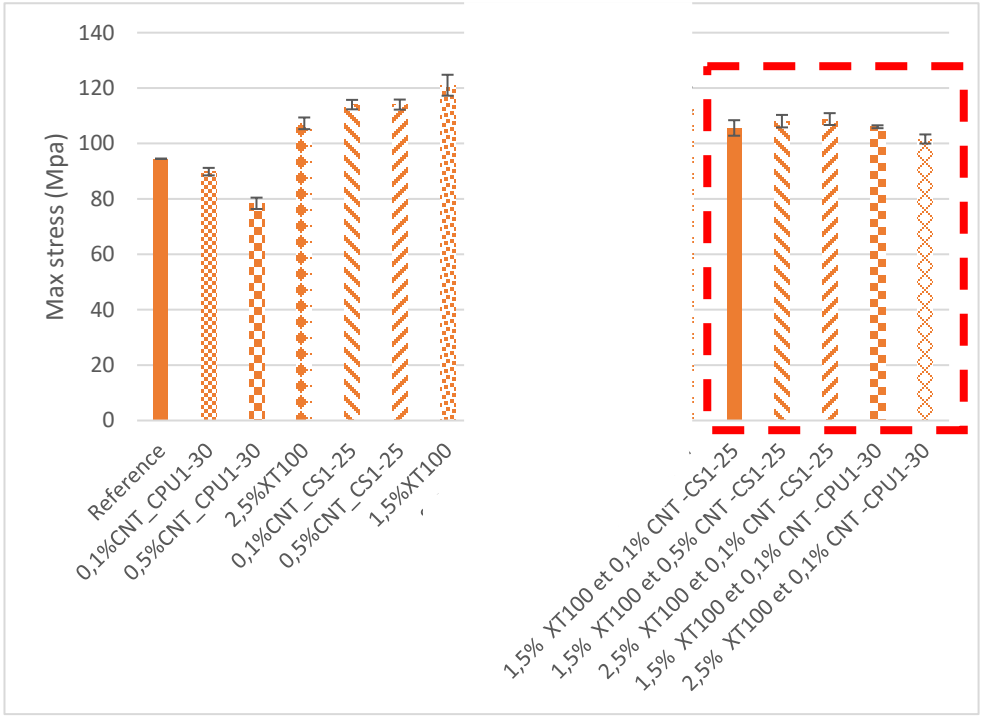
Mechanical characterization: ILSS



- 25% improvement in ILSS for both 2.5% impact modifier XT100 and 0.5% CNT_CS1-25 formulations

Synergetic effects ?

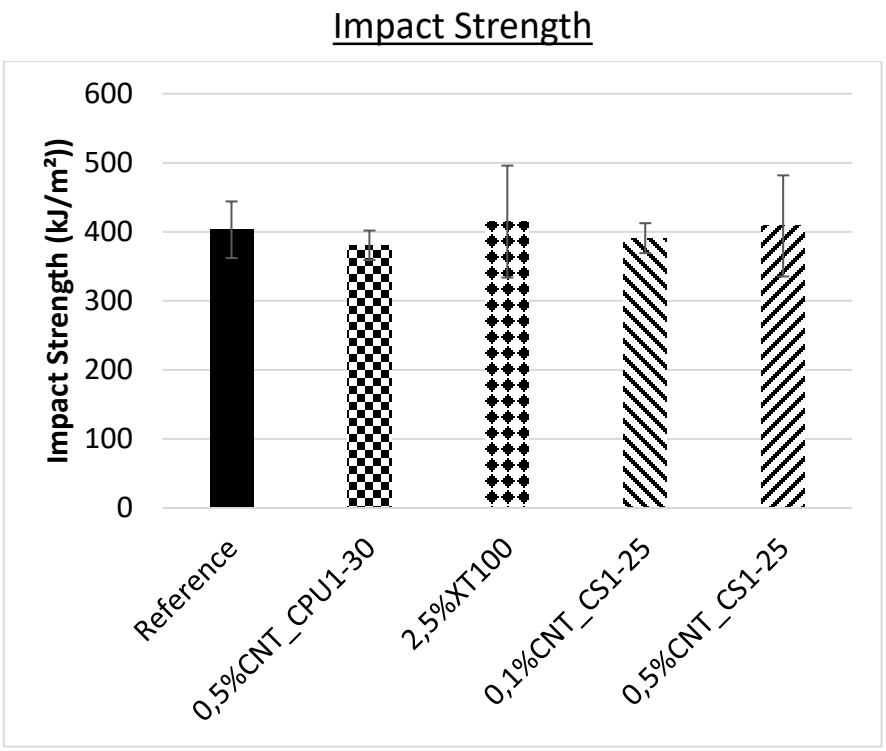
➢ Trials to mix the fillers : impact modifier and carbon nanotubes to observe synergetic effects



➢ No significant improvement of mechanical behaviour in traction at +/-45°

NEMMO
MAKING BLADES BETTER

Mechanical characterization: impact strength



No significant improvement of the matrix formulation in impact strength

NEMMO
MAKING BLADES BETTER

Perspectives

- Based on these results, 2 formulations were selected for manufacturing the full scale blades by NEMMO partner INPRE:
  - 0.5%wt Carbon Nanotubes dispersed inside the resin
  - 2.5%wt impact modifier dispersed inside the resin

Infusion of half blade using impact modifier reinforced matrix

✓ No dry zone

✓ No filtration of the fillers

Reinforced blade to be installed and tested in real sea conditions

NEMMO
MAKING BLADES BETTER

Thank you for your attention!

Dr. Célia MERCADER

CANOE, FRANCE

mercader@plateforme-canoe.com

www.plateforme-canoe.com

www.nemmo.eu @Nemmo_Project info@nemmo.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815278.

NEMMO MAKING BLADES BETTER