# Interfacial Performance of Composites by Fiber Bundle Tests: Impact of Nanofiller Dimension and Surface Chemistry

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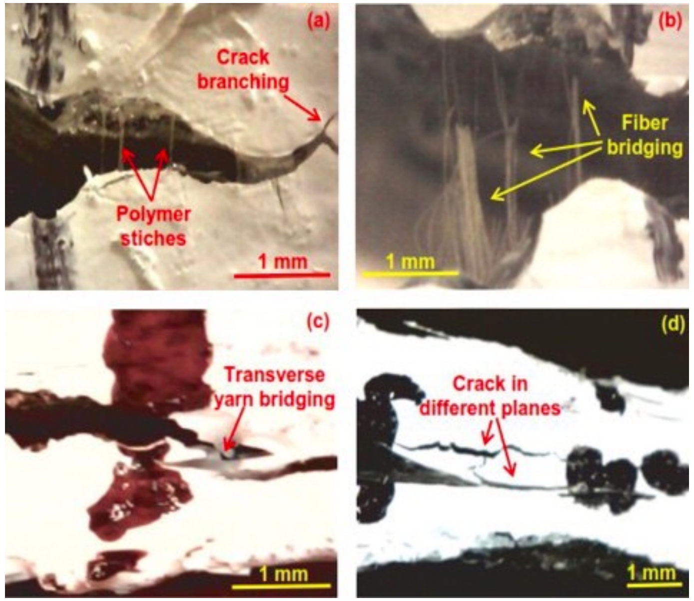
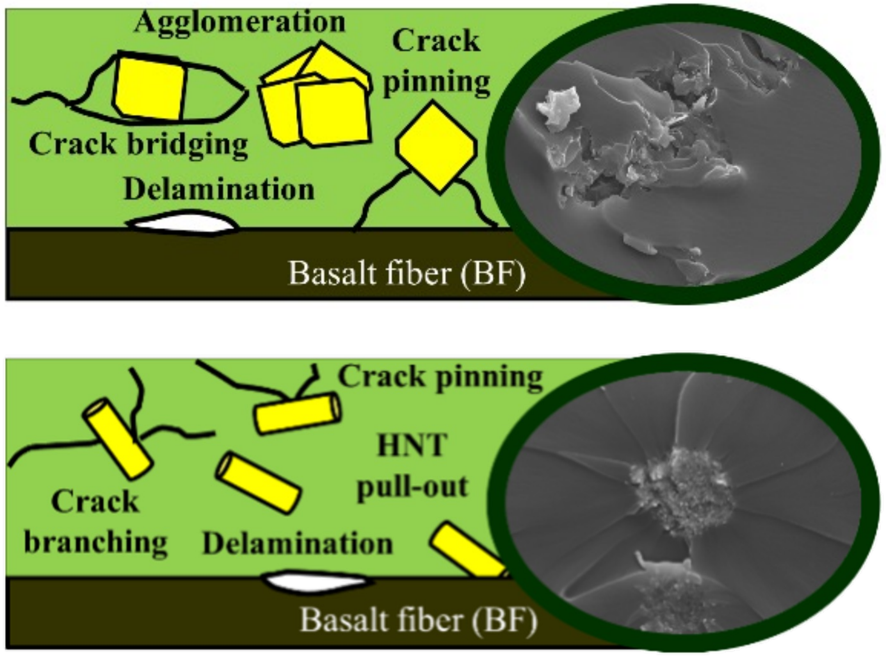
# Introduction

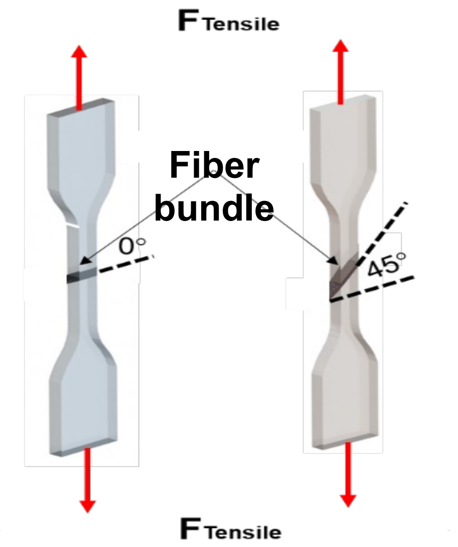
Weak interfacial bonding can lead to:
- Reduced mechanical properties
- Delamination and crack propagation
- Restricted applications
- Impaired durability


- Introducing nanofillers into the polymer matrix can result in exceptional mechanical performance enhancements in the fiber-matrix interface.
- Nanoparticle type and morphology affect the polymer matrix's fracture toughness.



# Fiber bundle test (FBT) → Interfacial bonding with nanofillers




<u>Advantages:</u>

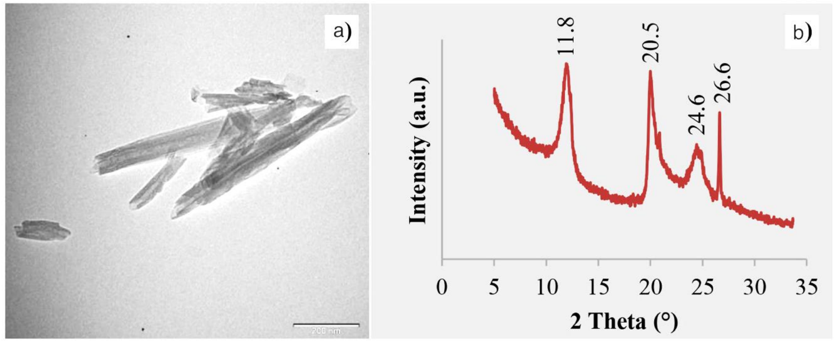
- Representative assessment
- Simplicity and efficiency
- Facilitates parameter study
- Micro-scale prediction
- Compatibility with real composites
- Early-stage evaluation
- Complementary to other tests

**MOTIVATION**

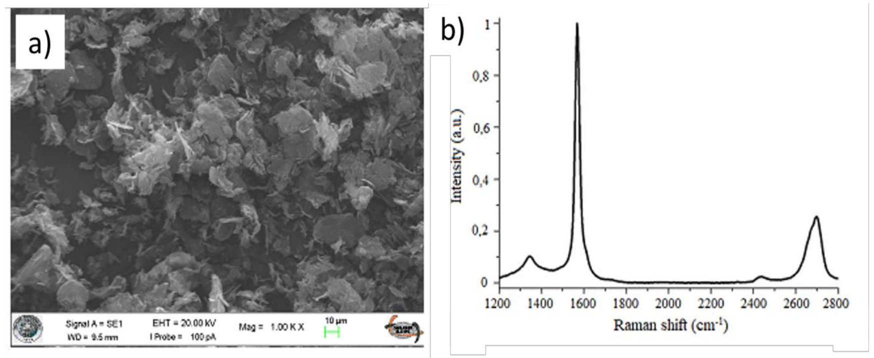
- Explore using nanofillers with different morphologies, HNT (1D) and GO (2D), and chemically modified surfaces to strengthen the fiber/matrix interphase.
- By incorporating these nanofillers into the polymer matrix, investigate their impact on interfacial bonding and evaluate how they contribute to enhanced mechanical properties using FBT.

# Sample preparation

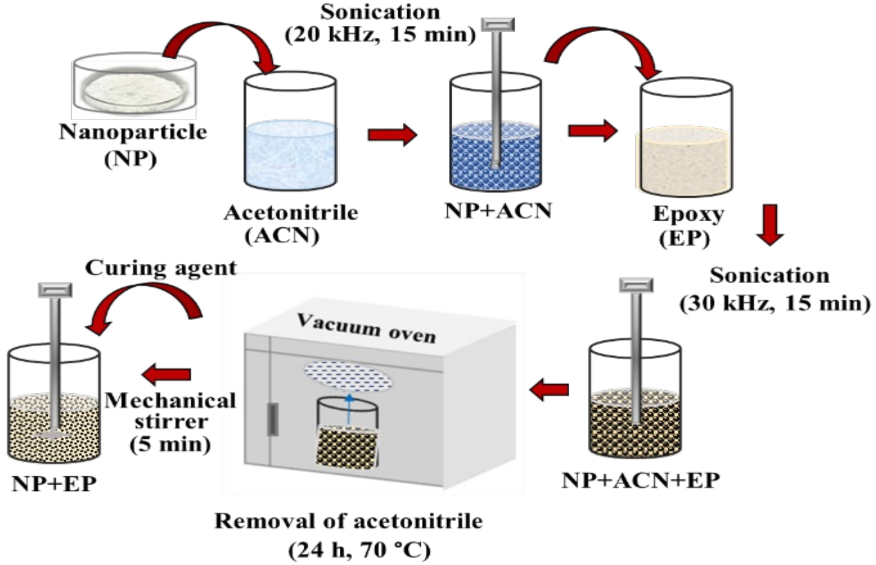
## Halloysite nanotubes (1D)



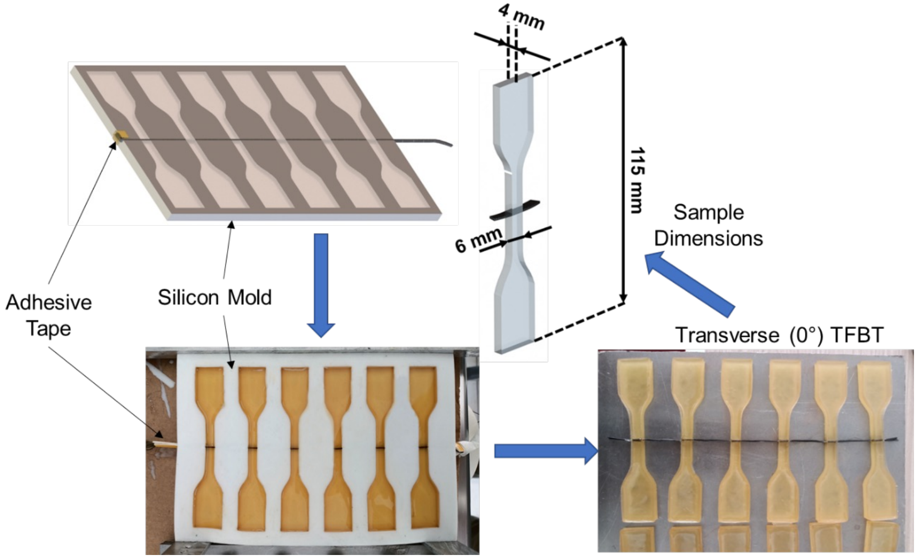

## Graphene nanoplatelets (2D)




## APTES modification of HNTs and GNPs




## Sample manufacturing







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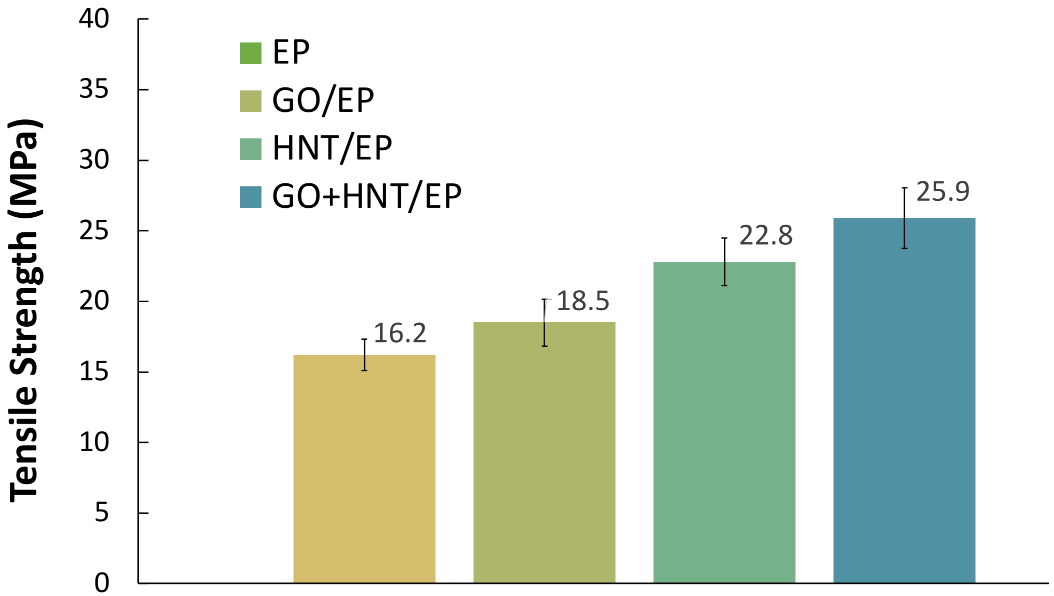
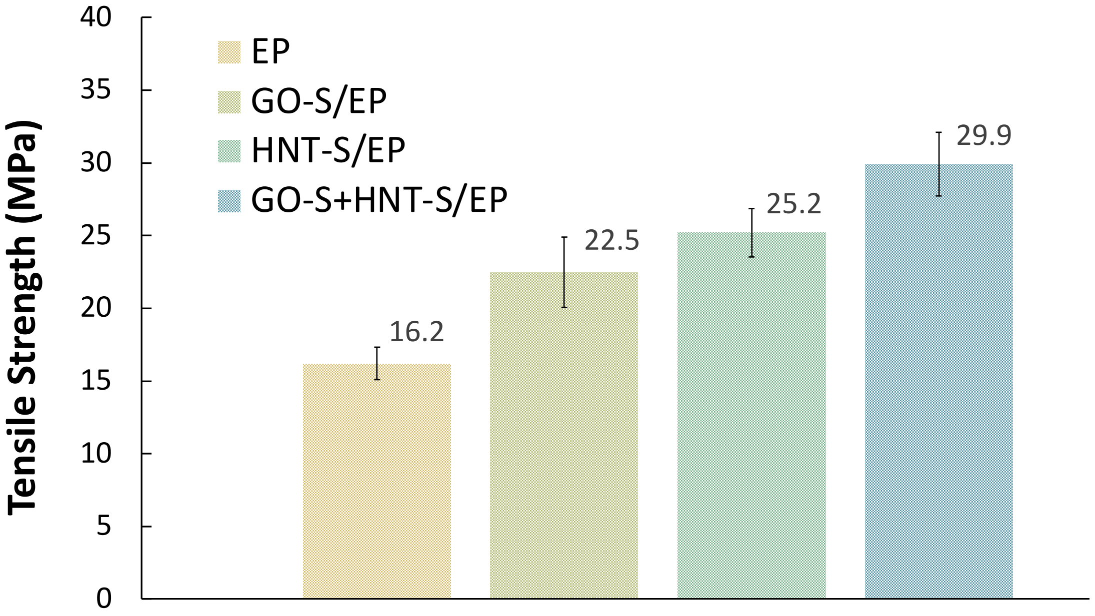
# Transverse fiber bundle tensile strength

Before surface treatment of nanoparticles




Nanoparticle surfaces chemically modified with APTES




- Epoxy modified with graphene oxide nanoparticles → crack pinning and crack branching mechanisms
- Hybrid epoxy matrix with halloysite nanotubes → toughness enhancing mechanisms: crack bridging and nanotube pinning
- Surface functionalized GO and HNT added to the epoxy matrix → interfacial strength reached the highest value.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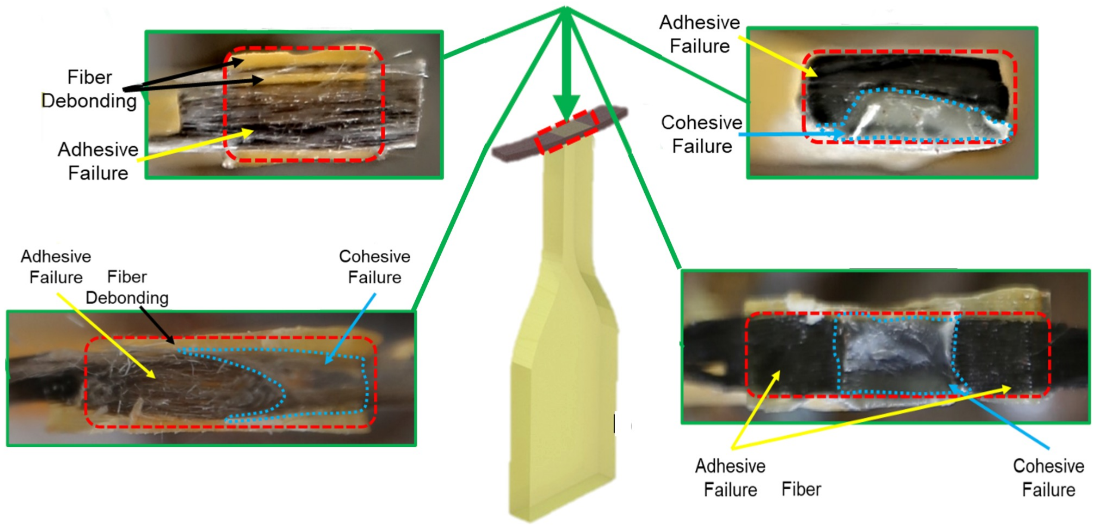
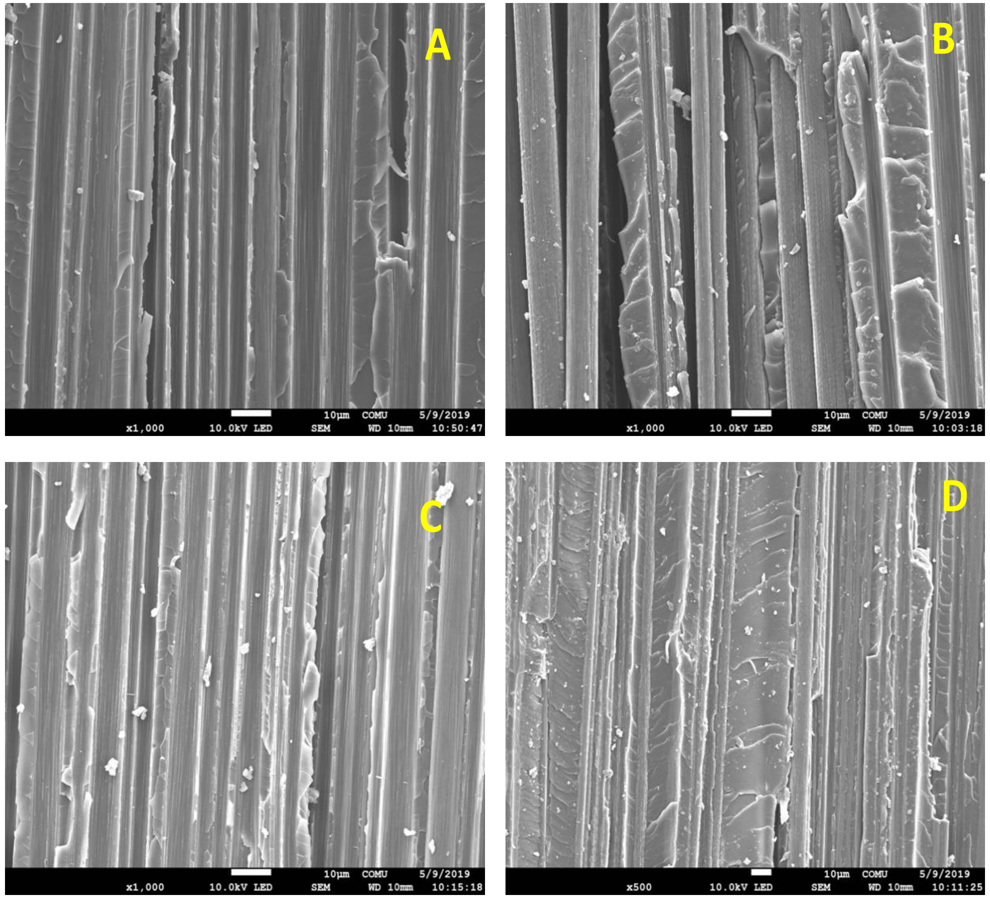
# Fracture Surface

## Adhesive or Cohesive Damage?




- With GO/EP (B) and HNT/EP (C) fiber-matrix interfacial interactions increased and interfacial strength improved.
- Increased surface roughness in HNT reveals the effectiveness of toughening mechanisms, which are more common in the impact of 1D nanoparticles on the fracture performance, especially bridging and nanotube pinning

A. Epoxy B. GO/Epoxy




C. HNT/Epoxy D. GO+HNT/Epoxy

# Conclusion

The impact of nanoparticle reinforcement on fiber-matrix interfacial mechanical performance in fiber-reinforced polymer composites are investigated using meso-scale fiber bundle tests for evaluating interfacial properties. Fiber bundle tests provided practical and accurate mechanical insights into the fiber-matrix interface.

This study serves to following tracks for composites:

- Enhanced mechanical properties
- Tailored toughening mechanisms
- Advancements in material design



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# Thank you!

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