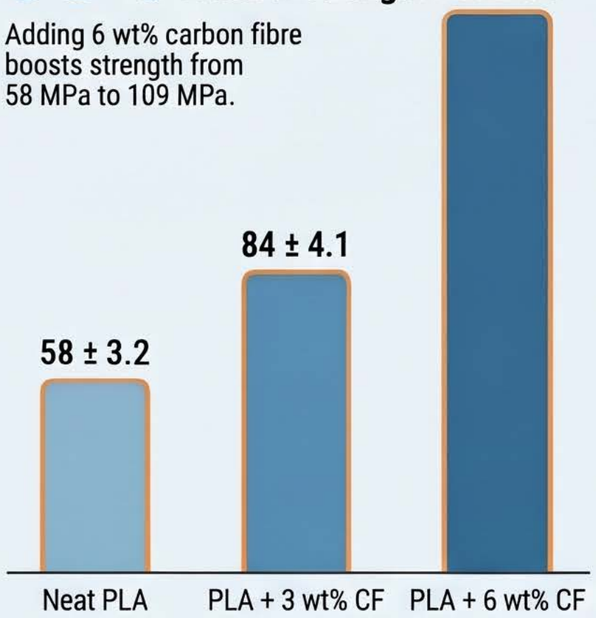
Stronger by Design: Enhancing 3D-Printed PLA with Carbon Fibre

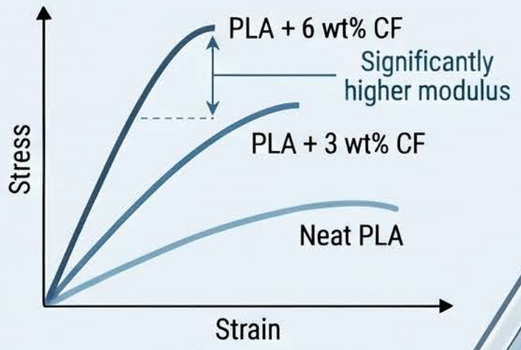
MECHANICAL PERFORMANCE BENCHMARKS

88% **Increase in Flexural Strength 109 ± 5.6**

Adding 6 wt% carbon fibre boosts strength from 58 MPa to 109 MPa.



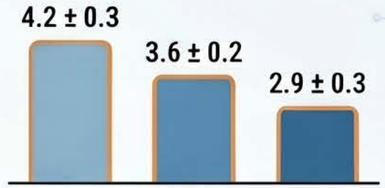
Enhanced Material Stiffness



Reduced Strain at Failure

Ductility drops from 4.2% to 2.9% as the composite becomes more brittle.

Reduced Strain at Failure



Comparison of mechanical properties across the three tested material variants.

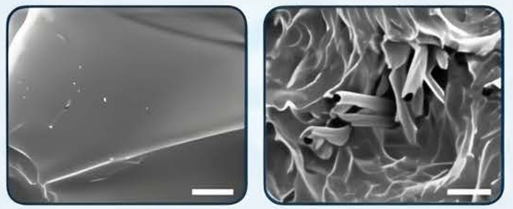
Material Composition	Flexural Strength (MPa)	Strain at Failure (%)
Neat PLA	58 ± 3.2	4.2 ± 0.3
PLA + 3 wt% CF	84 ± 4.1	3.6 ± 0.2
PLA + 6 wt% CF	109 ± 5.6	2.9 ± 0.3

MICROSTRUCTURAL FAILURE MECHANISMS

Effective Load Transfer

Short fibres redirect bending stress away from the polymer matrix to the reinforcement.

Transition to Semi-Ductile Fracture

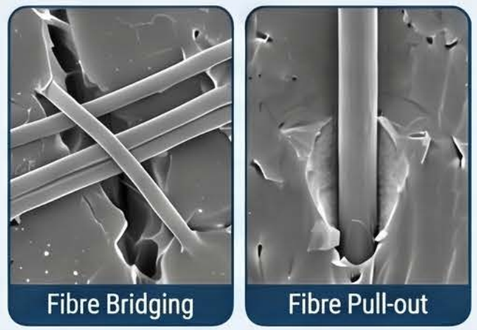


Quasi-brittle Neat PLA

Rough, tortuoue, fibre-dominated Morphology

Active Toughening Mechanisms

SEM analysis confirms failure is resisted via fibre bridging and fibre pull-out.



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