CORE-SHELL STRUCTURED TOW-PREG ENABLED ADDITIVE MANUFACTURING OF CONTINUOUSLY REINFORCED THERMOSET COMPOSITES

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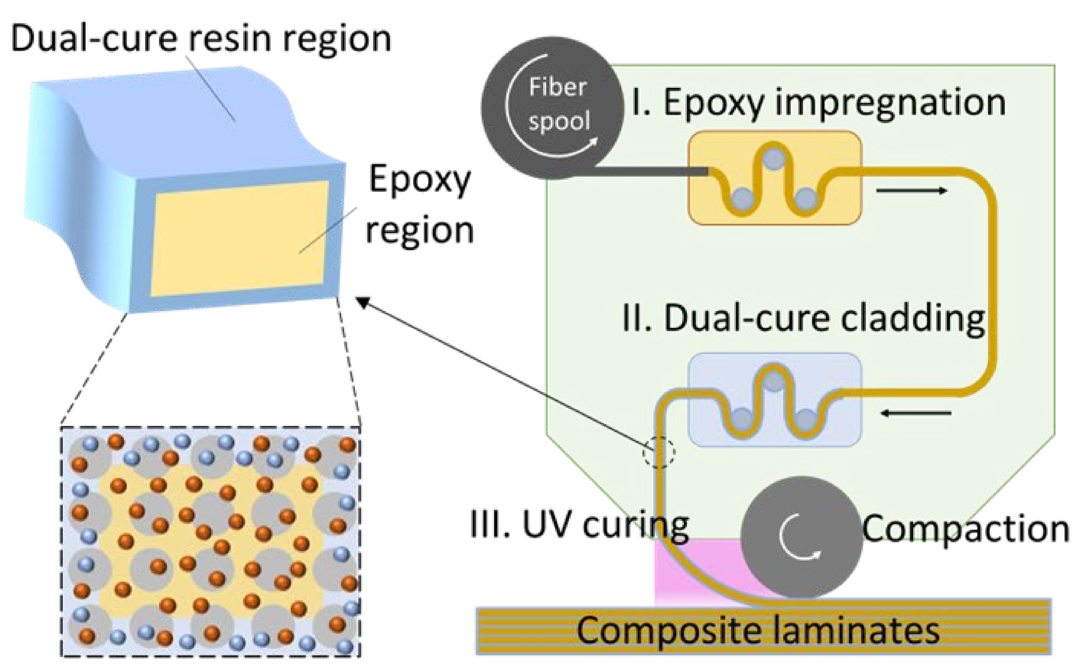
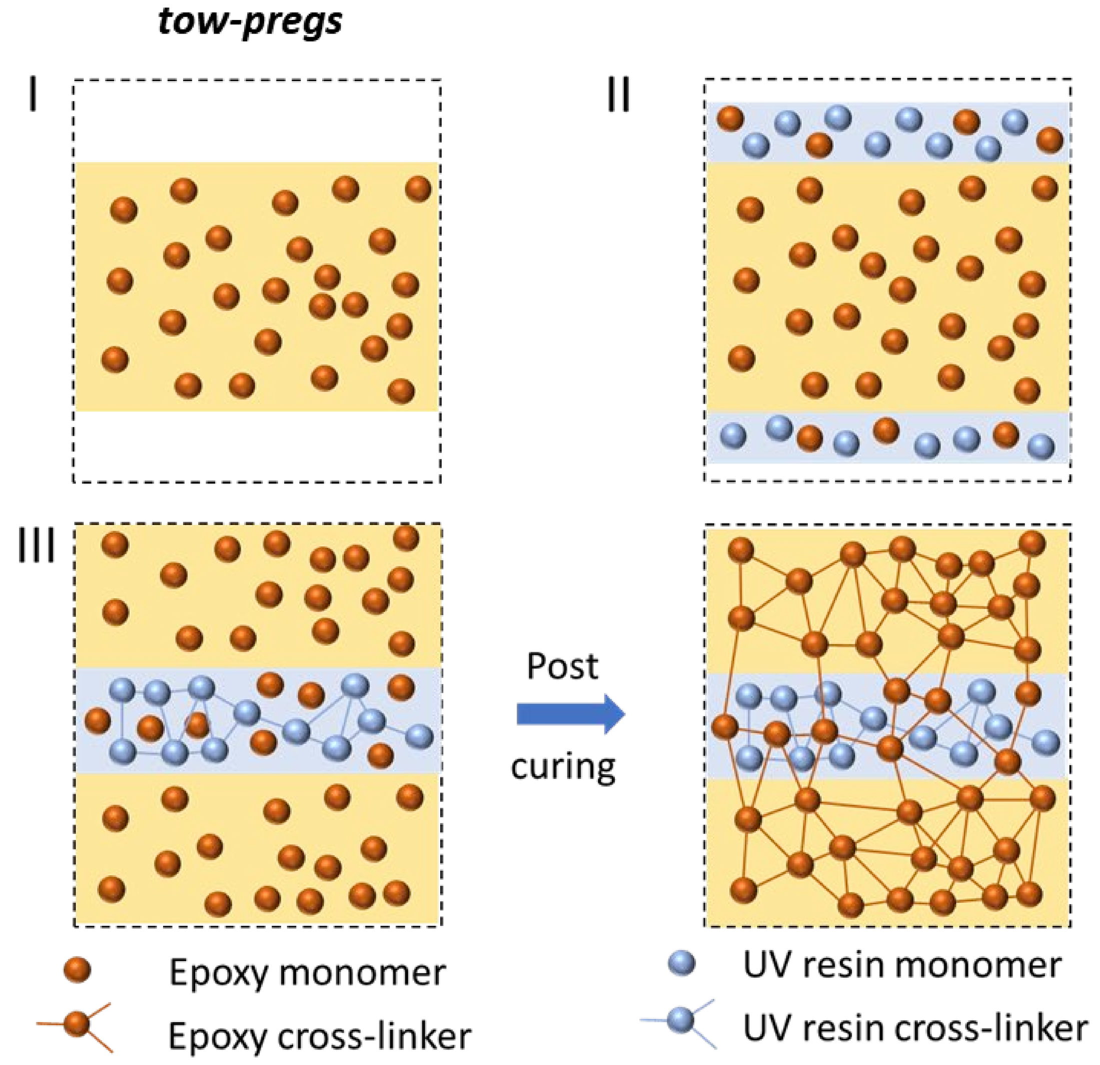
Introduction

- Continuous carbon fiber reinforced thermoset composites and their additive manufacturing are the main technical interest, due to high mechanical performances and better material quality and processability.
- We developed a rapid interlayer curing strategy called Tow-preg Cladding (TPC), which uses a thin coating of dual-cure resin at the interlayers.
- A sequential interpenetrating polymer network (IPN) is formed after UV and thermal curing in the interlayer regions, which improves interlayer bonding.

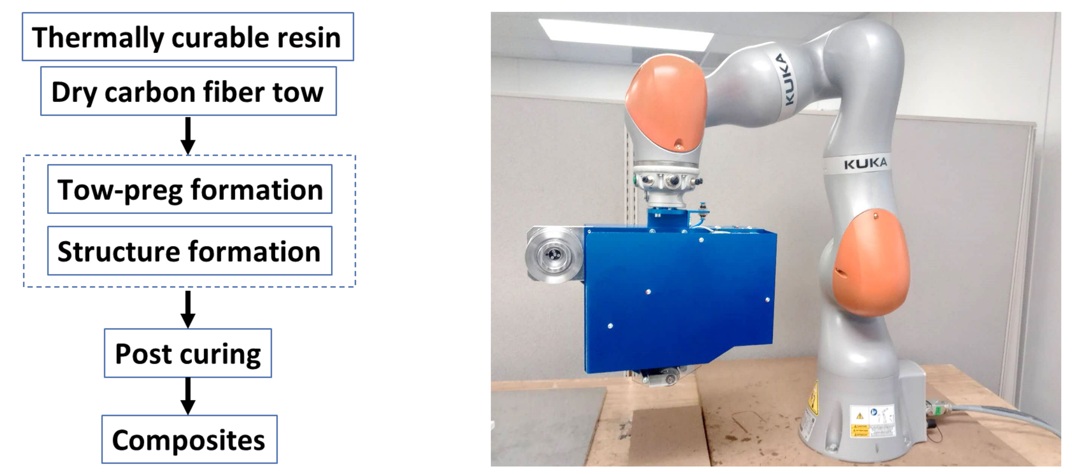


- *Core-shell structured tow-pregs*
- *3D printing process*

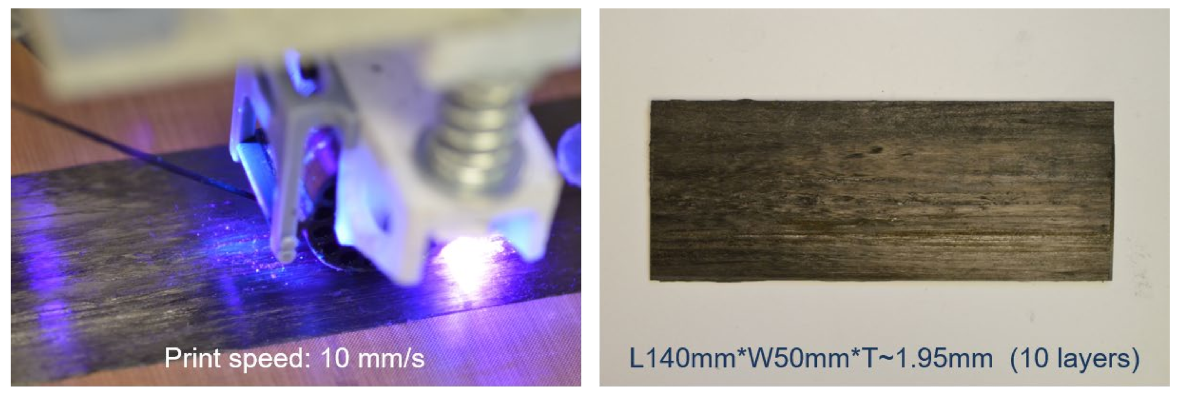


- *Dual curing enabled interpenetrating polymer network (IPN) at interlaminates*

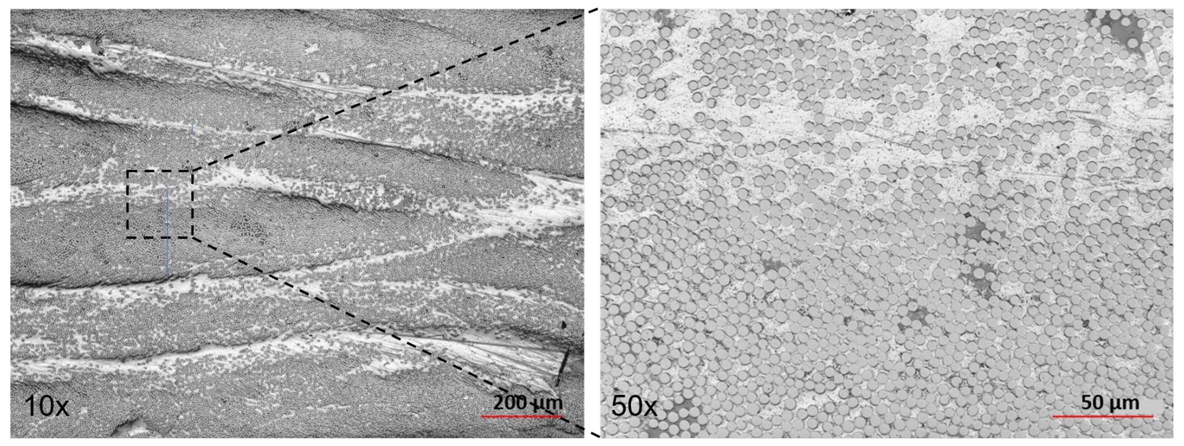
Methods & Analysis



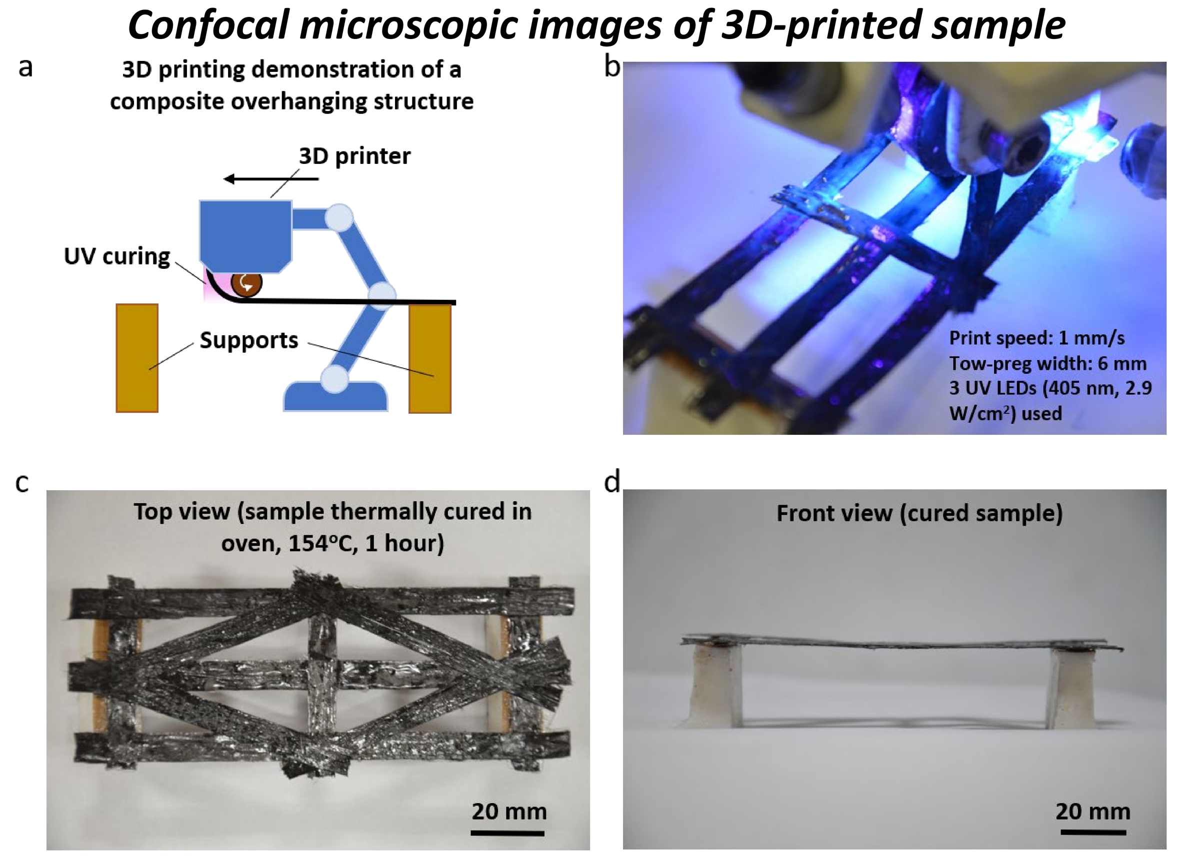
Our own developed 3D printer for continuous fiber/epoxy thermoset composites



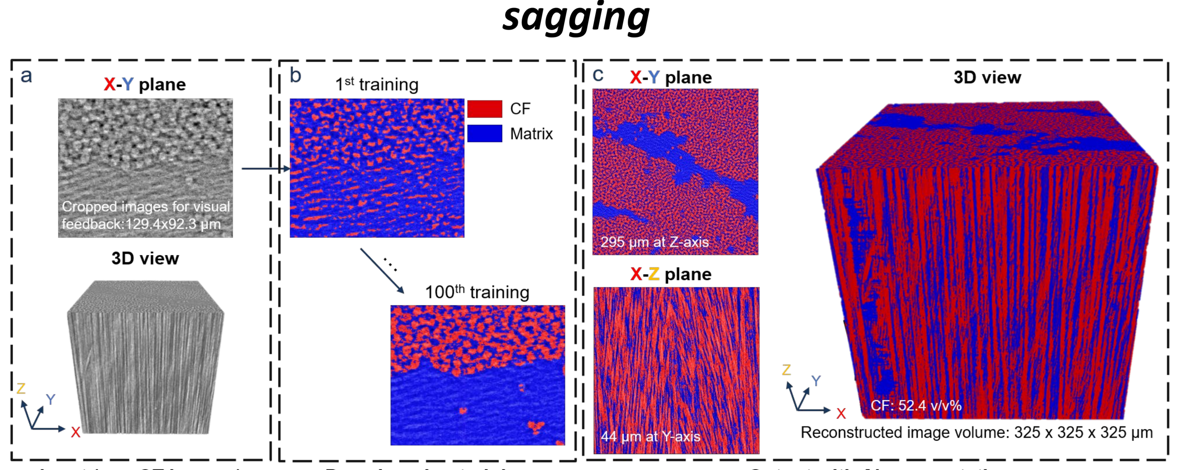
3D printing process and sample image



Confocal microscopic images of 3D-printed sample

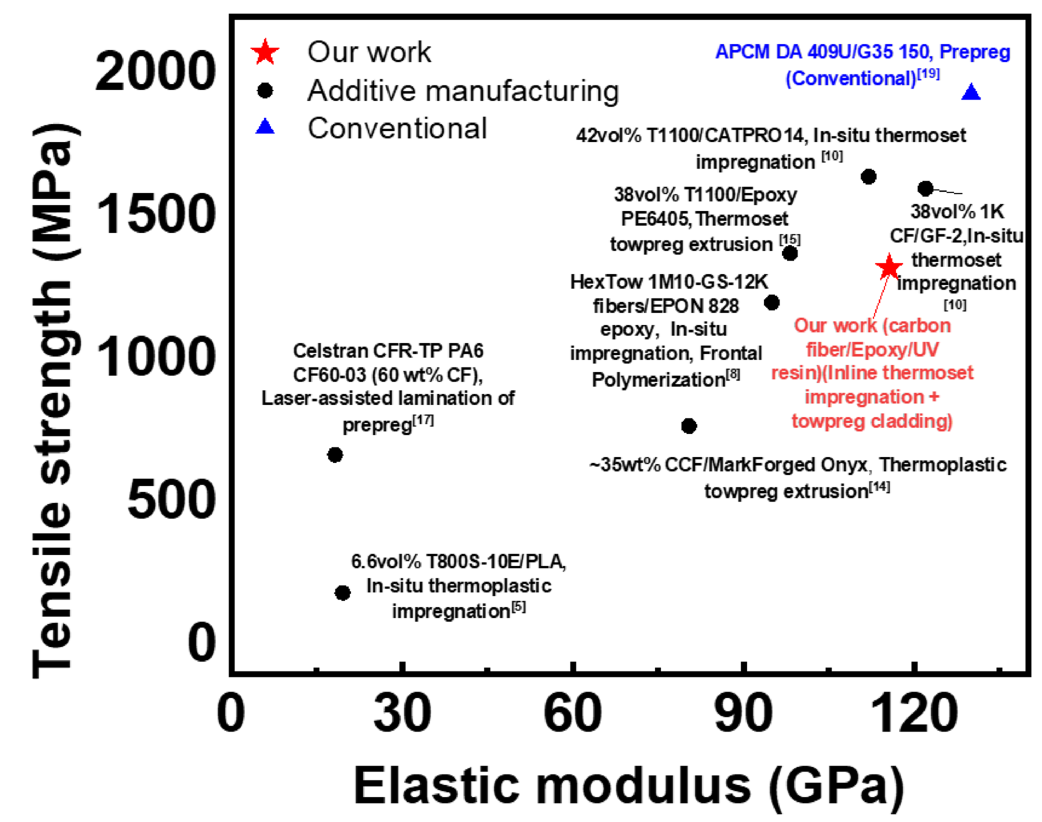


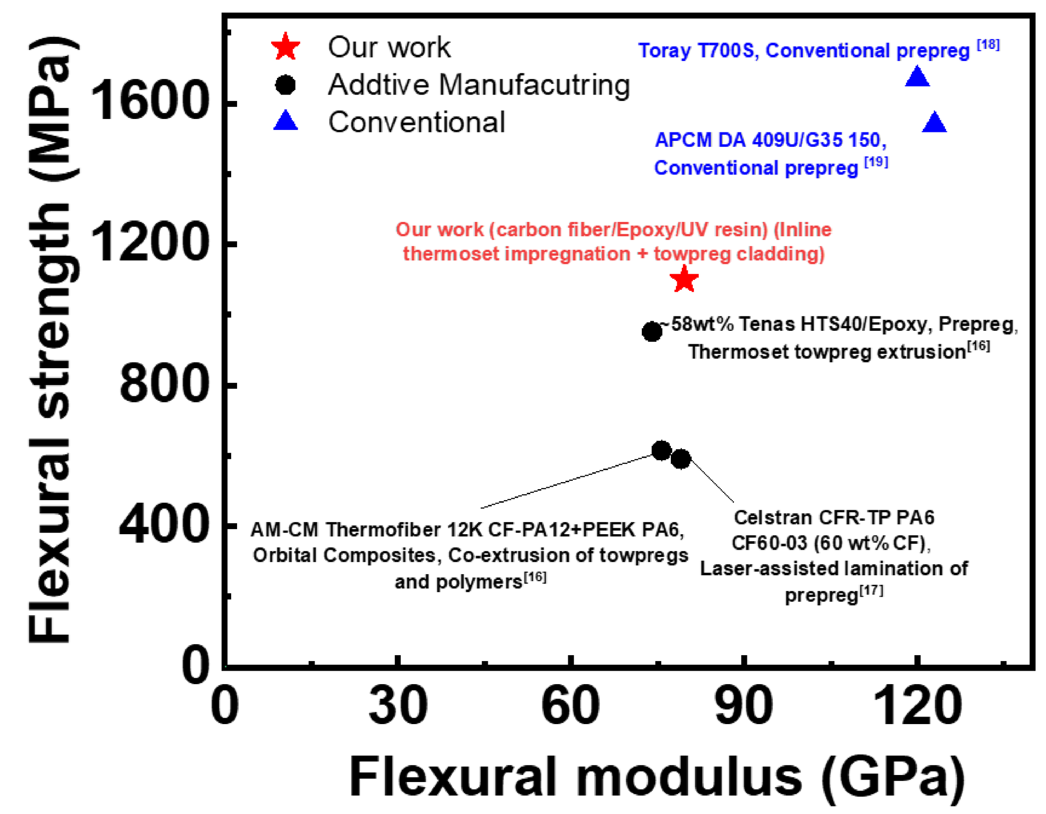
AM demonstration of self-supported overhang structure without sagging



Nano-CT image segmentation using deep learning training

Results





Mechanical Properties	Values	Test Standards
0° Tensile strength	1322.17 MPa	ASTM D3039
0° Tensile modulus	115.61 GPa	ASTM D3039
Interlaminar shear strength	47.35 MPa	ASTM D2344
Fiber volume fraction	54.4%	ASTM D3171
Degree of curing	91.4%	-
Flexural strength	1100.20 MPa	ASTM D790
Flexural modulus	79.64 GPa	ASTM D790

Conclusions

- We developed a composite 3D printing strategy for continuous fiber/thermoset composites.
- It forms core-shell structured tow-pregs and interpenetrating polymer network (IPN) across laminates.
- High mechanical performances were able to achieve, especially tensile strength ~1300 MPa, reaching the level of automotive industry.
- Self-supporting overhang structure and fiber steering structure were able to print using the continuous carbon fibers.

References

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