Additive Manufacturing Of A Non-planar Multifunctional Sandwich Panel

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Abstract

Airplanes noise reduction is a significant challenge for the aerospace industry. **Additive Manufacturing** (AM) allows the fabrication of new cost-effective structures that have complex shapes. In this work, we fabricated a multifunctional **non-planar** sandwich panel (SP) with **Fused Filament Fabrication (FFF)** technology using **High Temperature Reinforced Polymers (HTRP)** showing broadband sound absorption and load-bearing capabilities.

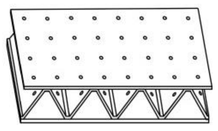
Specific objectives

1. Fabrication of a broadband sound absorber SP using HR
2. Fabrication of a heated enclosure for HT non-planar FFF
3. Additive manufacturing of a non-planar HTRP sandwich panel

Background and context

Leap engine (safran-group.com)

- SP with Helmholtz resonators (HR) to reduce airplanes motor noise

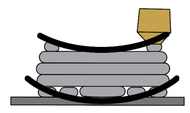


Acoustic SP (Meng et al.)

- One HR = narrow broadband sound absorption

FFF 3D printer with heated enclosure (aon3d.com)

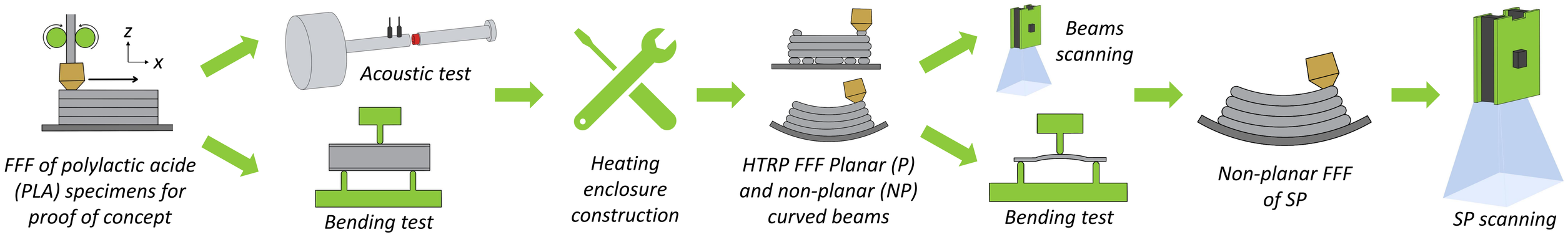
- Heatd environment required for HTRP FFF



Poor curvature approximation

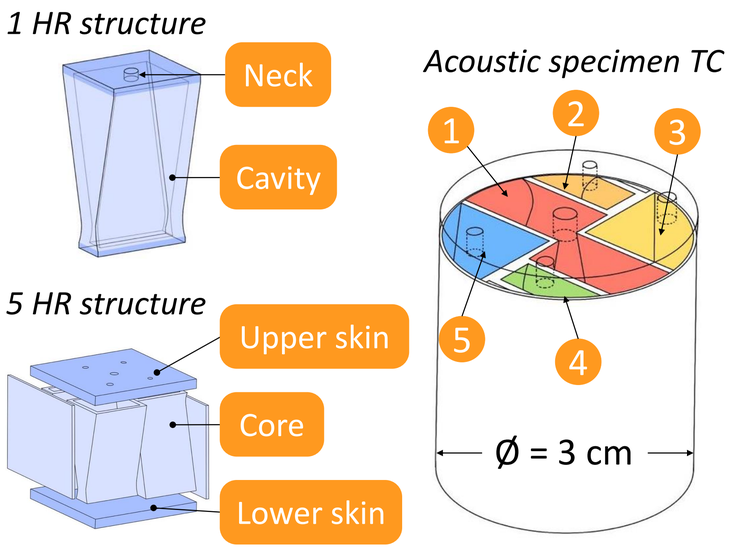
- Planar printing = poor curved surface approximation

Methodology



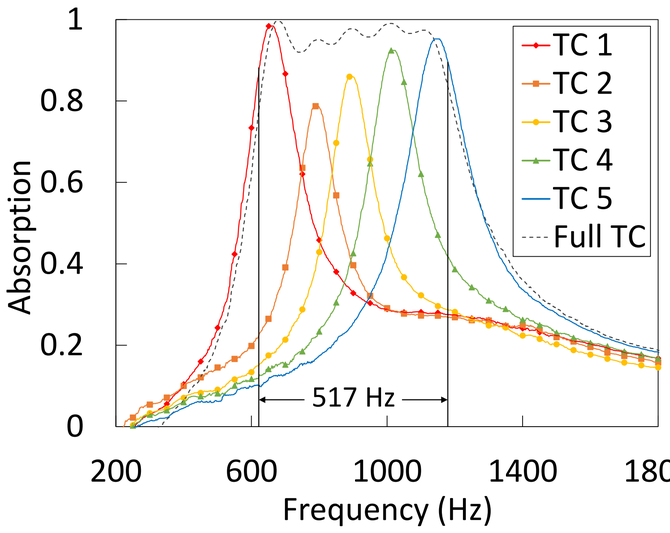
PLA proof of concept charaterization

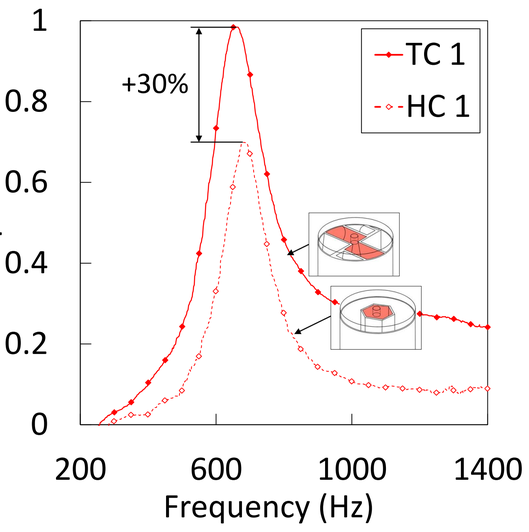
Trapezoidal compact (TC) acoustic cell



- Combination of 5 different HR inserted in the core of a SP

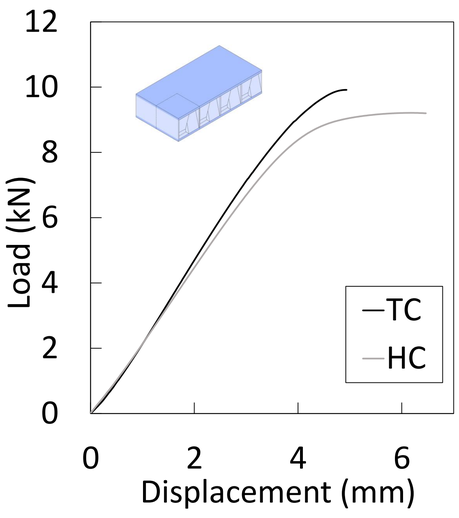
Acoustic Tests





- 90% of absorption over ~ 500 Hz
- Absorption of acoustic cell ~30% higher than its honeycomb (HC) benchmark

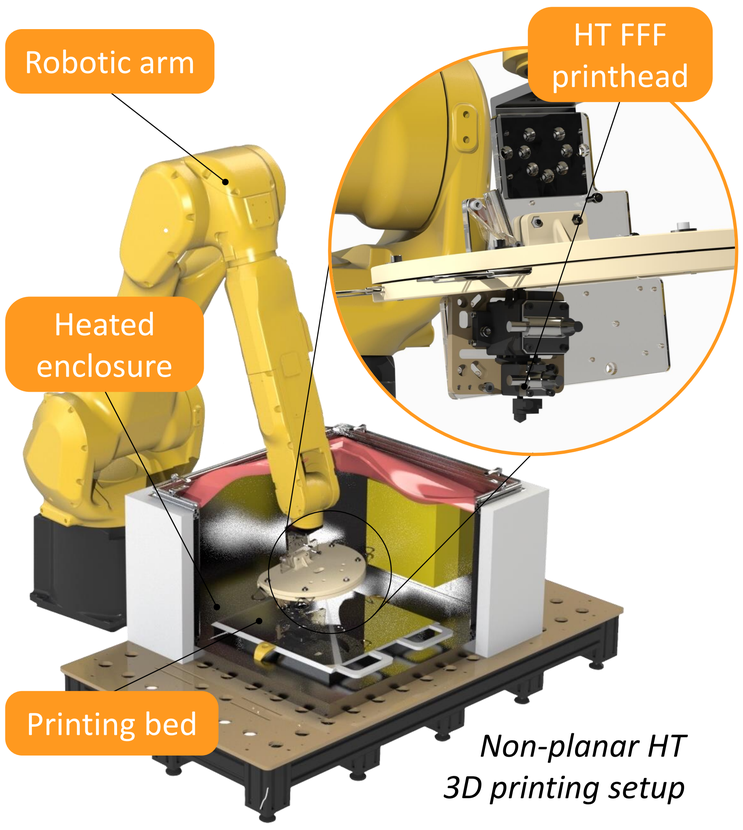
Bending Test



- Acoustic SP ~10% stiffer than its benchmark HC

HTRP non-planar sandwich structure

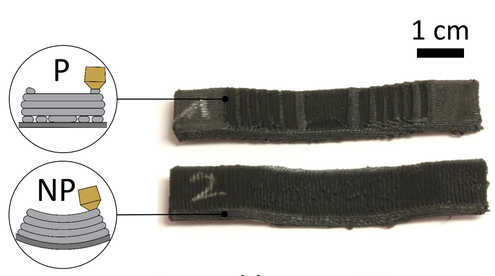
Heated enclosure for non-planar FFF



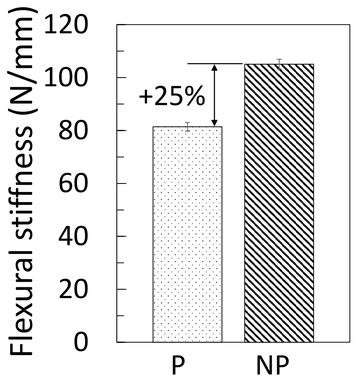
Non-planar HT 3D printing setup

- HT printhead (440°C) on a 6-axis robotic arm
- Temperature inside enclosure up to 120°C

Assessment of surface quality



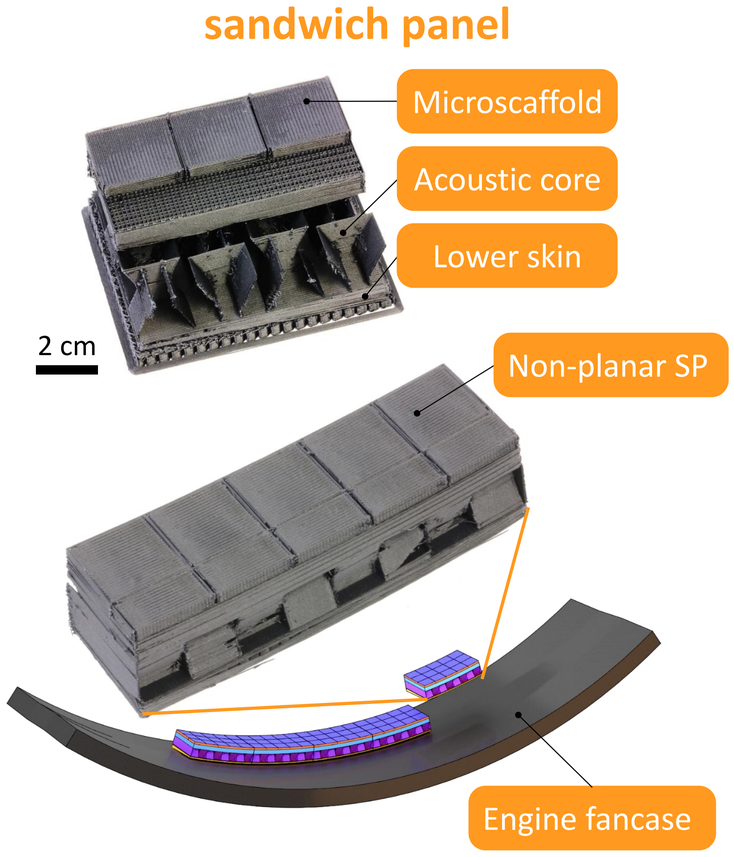
Curved beams 3D printed in HTRP 0°/90°



Comparaison of Euclidian distance of surface scans oto surface to print

- Non-planar AM increases stiffness (+25%)
- Precision of NP = ± 0,12 mm VS P = ± 0,20 mm

HTRP non-planar multifunctional sandwich panel



- Precision of the upper surface = ± 0,28 mm
- Less precision of the sides = ± 0,8 mm

Conclusion

- Absorption of acoustic structure above 90% over ~500 Hz broadband
- TC panel shows 10% higher stiffness than benchmark HC
- Non-planar beam 25% stiffer than planar beam
- High surface precision with non-planar FFF

Future work

- Testing acoustic and mechanical properties of a large panel
- Improving the precision of the printed parts via the recalibration of the FFF HTRP 6-axis robotic setup
- Setting a 2nd printhead for double material FFF

Acknowledgements

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