# Improving the Mechanical Performance of Additively Manufactured Continuous Carbon Fiber Reinforced Polymers Through Annealing

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## Problem:

- Additive manufacturing allows for the creation of precise complicated geometries while carrying the disadvantage of poor material properties.

## Goal:

- Increase material properties by reducing voids and increasing crystallinity.

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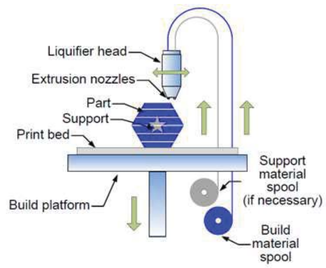


Figure 1: Typical additive manufacturing printer

Wang X, Jiang M, Zhou Z, Gou J, Hui D. 3D printing of polymer matrix composites: A review and prospective. Composites Part B: Engineering. 2017;(110):442-458.

## Methods:

- Thermally treat printed test coupon geometries.
- Characterize material properties through flexural and short-beam shear testing.
- Qualitatively analyze voids and microstructure through scanning electron microscopy.

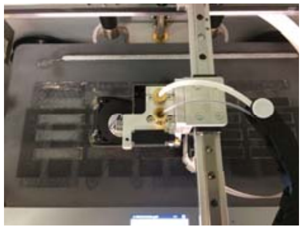

Figure 2: Printing of flexural test coupons

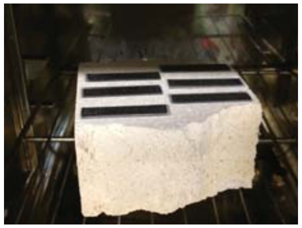

Figure 3: Thermal treatment of flexural test coupons

Figure 4: Loading of flexural test coupon

## Results:

- Voids from printing were largely unaffected.
- Voids between print layers showed signs of minimizing at two of the thermal treatment set points.
- Material properties largely unaffected by thermal treatments.

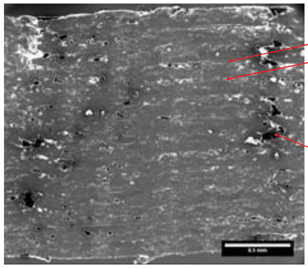


Figure 5: 65x SEM image of non-treated continuous fiber polymer composite.

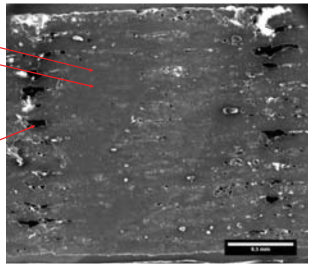

Figure 6: SEM image of 100° treated continuous fiber polymer composite.

## Future Work:

- Perform DSC to calculate optimum cold crystallization temperature for carbon/nylon-6 composite.
- Perform DMA to determine glass transition temperature for carbon/nylon-6 composite.
- Print, thermally treat and characterize new test coupons based on DSC and DMA results.

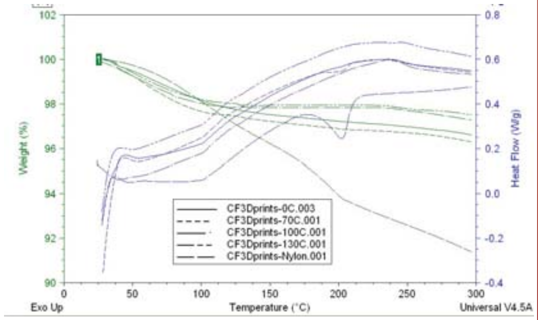


Figure 7: DSC results of carbon/nylon-6 composite across several thermal treatments