

Compression Molding Fabrication of C/C Composite Produced Via Highly-Processable BODA-Derived Precursor Resin

February Update

Problem Statement

The purpose of this project is to demonstrate the high processability of (BODA Derived Resin) BDR by creating C/C test coupons via compression molding. Compression molding, being a simplified method for creating carbon/carbon composite parts, was selected as the manufacturing method. Our process was designed for fabricating coupons for tensile testing via ASTM D3039.

Objectives

- **Develop compression molding manufacturing method using BODA as a precursor carbon matrix and create test coupons.**
 - **Equipment – (100%)**
 - **Mold – (100%)**
 - **Manufacturing Method – (100%)**
 - **Coupon Manufacturing – (100%)**
- **Characterize mechanical and material properties – (0%)**
 - **Scanning Electron Microscopy (SEM)**
 - **Coefficient of thermal expansion**
 - **Young's Modulus**
 - **Shear Modulus**
 - **Poisson's ratio**

Research Plan for February

Manufacture five successful coupons, cut them, carbonize them, perform tensile testing on them. Organize data, pictures, and methods and compile them into the AIAA paper.

Tasks Accomplished

Our first coupon manufacturing resulted in damage and deformation to the mold. The pins were not aligned when the pressure was added to the mold, and so the steel pins bent the male aluminum pinholes resulting in some deformation. The first accomplishment this year was getting the mold realigned and fixed. Unfortunately, this resulted in extreme problems down the line. If it isn't broke don't fix it.

*Josh Brown, Josh Griffin,
James Armstrong,
Patrick Madden*

8 total coupons were manufactured in the late Jan.-late Feb. time period. Coupons were manufactured on Jan 22, Jan 29, Jan 30, Jan 31, Feb 7, Feb 11, Feb 13, Feb 18. Coupons manufactured on Jan 29, Jan 30, Jan 31, Feb 7 were failures. These coupons buckled inside the mold upon cooling, causing a sinusoidal plastic deformation. Due to the resulting intermittent layer delamination and residual stress in the matrix, they were considered failures.

We determined the issue was that at the end of curing, the aluminum mold and the carbon piece within have different coefficients of thermal expansion, and when the part gets to about 150 degrees Celsius, the aluminum has drastically shrunken and compressed the coupon such that it fails. This occurs when the coupon has been left in the mold and allowed to cool to room temperature. This was fixed by removing the coupon as soon as the mold was removed from the heat press. This resulted in three successful coupons, but unfortunately the last one failed upon removal due to delamination from the stress of prying it out of the mold. The coupon on February 18 was not completely cured but should not be an issue when we carbonize to 1700 degree Celsius.

Research Plan for *March*

This month, we plan to carbonize the coupons to either 1700 C, and then proceed with tensile testing. If time allows, we will organize a Scanning Electron Microscopy (SEM) experiment. The acquired data and methods will also be compiled, processed, and input into the AIAA report due on March 3rd.

Performance to Plan

Unfortunately, a massive problem arose with the mold. The method of manufacturing had to be painstakingly tweaked to resolve the issue, and by that time a fortnight had passed. This resulted in a lot of our set deadlines being pushed back, and we may not have structural data for the AIAA conference. Regardless, the data will be collected, and we are moving forward.

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Team Member	Tasks to Complete	Estimated Completion Date	Actual Completion Date
Josh Brown	1. Make Abstract to reach deadline	2/3/2025	2/3/2025
	2. Write AIAA report	3/1/2025	Still Underway
	3. Carbonize 6 Coupons	2/12/2025	Still Not Completed
	4. Orchestrate Tensile Testing	2/15/2025	Still Not Completed
	5. Coordinate porosity and density experiments	2/15/2025	Still Not Completed
Joshua Griffin	1. Write into AIAA report describing creating the mold, why design choices were taken, and some schematics on final result.	3/1/2025	Still Underway
	2. Cut 5 Coupons to shape	2/7/2025	2/21/2025
	3. Deliver delaminated coupon to Alejandro Martinez as compensation for CNC machining consultation	2/1/2025	2/1/2025
	4. Perform Tensile Testing	2/20/2025	Still Not Completed
	5. Preliminary designs for next generation mold	2/28/2025	Still Underway
James Armstrong	1. Update Website with relative documentation	3/1/2025	Still Underway
	2. Add pictures to website	3/1/2025	Still Underway
	3. Create figures for AIAA report using data acquired from testing	3/2/2025	Still Underway
	4. Assist in cutting/carbonization	2/12/2025	2/21/2025
	5. Assist in tensile testing	2/20/2025	Still Not Completed
Patrick Madden	1. Validate manufacturing process via using Dr. Kim's composite lecture notes as well as Cody Hardin's industry experience.	3/1/2025	Still Underway
	2. Manufacture 2 coupons @ ACI w/ Matthew Roberson	1/31/2025	1/31/2025
	3. Manufacture 3 coupons @ ACI w/ Matthew Roberson	2/7/2025	2/18/2025
	4. Document manufacturing process and identify potential points of improvement	3/1/2025	Still Underway
	5. Write excerpts for AIAA report on manufacturing process	3/1/2025	Still Underway

Signatures

The student named above has discussed their monthly progress with me.

Dr. Han-Gyu Kim

Date

*Josh Brown, Josh Griffin,
James Armstrong,
Patrick Madden*

Dr. Ernesto Borrego

Date