James Armstrong, Josh Brown, Joshua Griffin, Patrick Madden

Thermal and Mechanical Characterization of C/C Composite Produced via Highly Processable BODA-Derived Precursor Resin System

October Update

Problem Statement:

This project seeks to characterize the Carbon/Carbon (C/C) Composites derived from Bis-ortho-diynylarene (BODA) precursor resin system. We seek to highlight the high processability of this precursor resin system and shortened manufacturing times and confirm the quality of student fabricated C/C composite materials via mechanical and thermal characterization. We will characterize Young's modulus, shear modulus, Poisson ratio, coefficient of thermal expansion, and other mechanical and thermal properties to compare to phenolic C/C composites.

Objectives:

- **Develop compression molding manufacturing method using BODA as a precursor carbon matrix and create test coupons.**
  - **Equipment – (100%)**
  - **Rheology – (0%)**
  - **Mold – (100%)**
  - **Manufacturing Method – (85%)**
  - **Coupon Manufacturing – (20%)**
- **Characterize mechanical and material properties – (0%)**
  - **Scanning Electron Microscopy (SEM)**
  - **Coefficient of thermal expansion**
  - **Young's Modulus**
  - **Shear Modulus**
  - **Poisson's ratio**
- **Compare gathered data with industry standards to show benefits of using BODA as precursor to carbon matrix composite manufacturing – (0%)**

Research Plan for October

For October, we plan to finish the creation of our test coupons. We have planned Monday, October 14th, as our tentative date for coupon manufacturing. Once we have our finished polymer matrix composite, then we will carbonize to 1000 °C under inert gas in a tube furnace in Swalm. After carbonization, we will be able to run tensile tests with Dr. Kim. Once thermo-mechanical testing has finished, we will discuss with our advisors the necessity of expanding the scope of our project (characterizing the polymer matrix composite as well).

Tasks Accomplished

In October, we completed three compression-molded parts at ACI. We encountered issues with resin-starved composites in our first trial. We tried different ratios and ply amounts to amend this problem. Our second coupon was also a failure, as the ply's did not stick together coming out of the mold. Required BODA system amounts were recalculated. Our third composite part was the most successful coupon yet, but it was still resin starved. It

seemed to be 30% resin and 70% carbon. The coupon was carbonized, and the fibers were very brittle. The carbonized coupon could be broken with minimal hand exertion, possibly due to lack of resin. The two layers of the coupon delaminated while the coupon was cut to shape. We are behind schedule, but not in the extreme. Fortunately the strength testing can be done quickly, and the carbonization takes a day. There is no precedent for what we are doing, so our process is based on knowledge of the chemistry of what is happening.

Research Plan for November

This upcoming month we will be doing 1-2 compression molds a week, optimizing and fleshing out our process the entire way. The BODA system mass for our coupons will worked on and updated. If successful results are yielded, we will proceed with carbonization and testing.

Signatures

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

_____	_____
Ernesto Borrego, Ph.D.	Date
_____	_____
Han-Gyu Kim, Ph.D.	Date

Appendix

Composite 1

Composite 2

Composite 3