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

September 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 test the processability of this precursor resin system and 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 industry standard C/C composites.

Objectives:

- **Identify a fabrication method for BODA composite test coupons.**
  - **Equipment – (100%)**
  - **Rheology – (0%)**
  - **Mold – (40%)**
  - **Manufacturing Method – (50%)**
  - **Coupon Manufacturing – (0%)**
- **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 previously published data on phenolic–based C/C to identifybenefits/drawbacks of using BODA resins for C/C – (0%)**

Research Plan for September 2024

Discuss what you had planned to accomplish for the month. After the first update (September), this should be taken directly from the previous update.

The plan for September was to identify a fabrication process for our test coupons made from a HAND proprietary BODA precursor resin. To do this, a starting method for compression molding (temperature, pressure, dimensions, time under pressure) is created from requirements for thermo-mechanical testing as well as data of the chemical properties of BODA.

Furthermore, a mold for test coupons must be custom designed and manufactured. This process involves design and creation of the mold in CAD, CAM, and physical machining of the part on a CNC mill, and then pressing in alignment pins into the female mold. A compression molder/heat press and tube furnace must be secured for use in manufacturing, and training performed on these machines. Ideally, if the mold is successfully created, the first coupons would be created at the very end of the month.

Tasks Accomplished

Discuss what you actually completed, problems encountered, and where you are at on your overall timeline.

During September, our team gained access to Advanced Composites Institute's (ACI) heated compression molder. We have also procured a suitable tube furnace. Mr. Griffin created a design of our molds with assistance from Mr. Brandon Warner. Our molds shall create coupons with dimensions of 260mm by 26mm by 1 mm utilizing Aluminum T6061. As of this moment (Oct. 2), we have manufactured the female die. We have created a website, seniorseminar2025.github.io, to document our methodologies, cited documents, and other documents. Unfortunately, test coupons manufacturing has not begun, but will as soon as the male mold is finished. Mold design was stalled when considering options for mold removal upon curing. Time for manufacturing on the 5-axis CNC mill was also an issue due to limited availability.

Research Plan for October

Discuss what you plan to accomplish for the upcoming month.

For October, we plan to finish the creation of our test coupons. We have planned Monday, October 14th, as our tentative date for our first resin infusion. Once we have our finished polymer matrix composite, then we will carbonize to 1000 °C under inert gas in a tube furnace. 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).

Signatures

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

Ernesto Borrego, Ph. D.

10.04.2024
Date

Han-Gyu Kim, Ph. D.

10/03/2024
Date