IMPROVEMENT OF THE DENSIFICATION PROCESS OF CARBON/CARBON COMPOSITES

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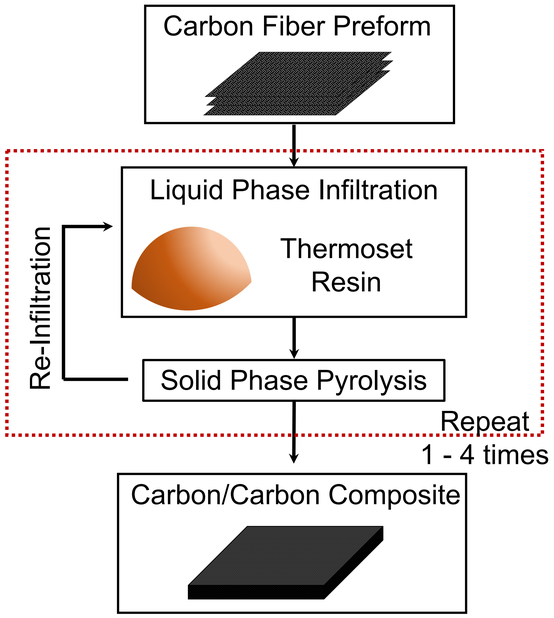
Introduction

Carbon/Carbon composites (CCC) manufacturing:



Densification Process

- Repetition Infiltration/Pyrolysis.
- Takes several months to complete.

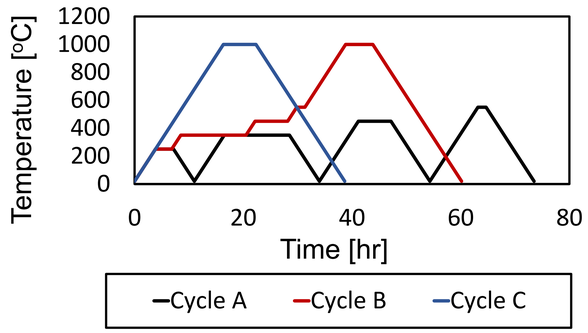
Improvement of Densification

- Tailor pyrolysis schedule to control connected porosity development.
- Find re-infiltration parameters to reduce time to fill connected porosity.

Permeability of CCC

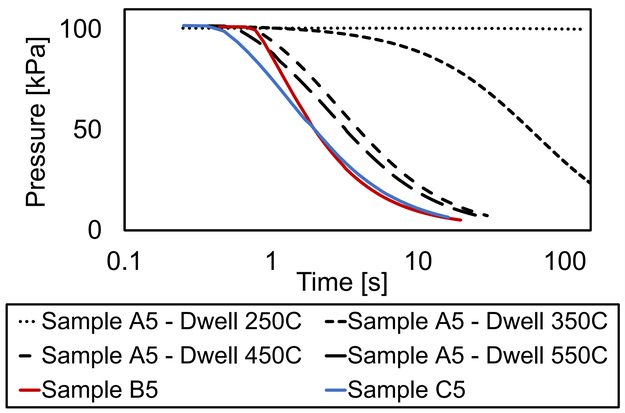
- Key parameter for characterization of connected porosity.
- Describes gas evacuation during pyrolysis.
- Determines resin permeation during re-infiltration.

Pyrolysis Schedules

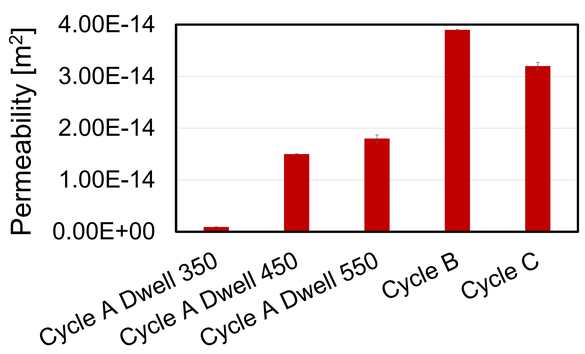


Characterization of Permeability

Pulse-decay experiment at different levels of degradation.



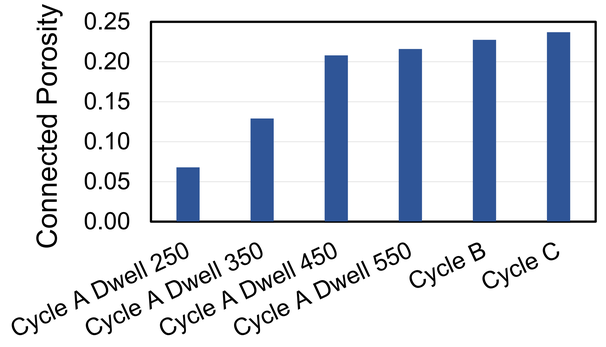
Measured Permeability



Characterization of Porosity

Comparison of pycnometry and micro-computed tomography (CT).

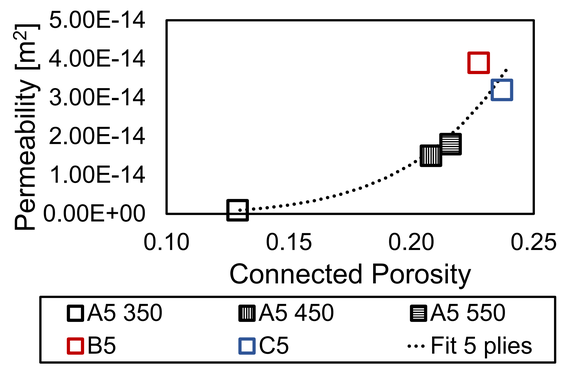
Measured Porosity by Pycnometry



Pycnometry is more accurate than CT, but CT is necessary for visualization of 3D microstructure.

Correlation of Permeability and Porosity

Necessary for simulations on re-infiltration and matrix degradation during pyrolysis.



Improvement of the Re-infiltration Process

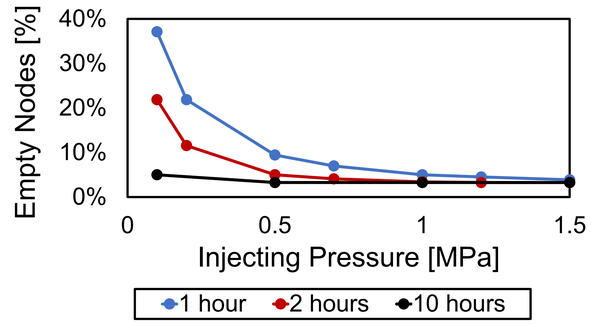
Measured permeability is used in numerical simulations of the RTM process to find the process parameters to fill the connected pores in the least amount of time.

Simulations of Re-infiltration

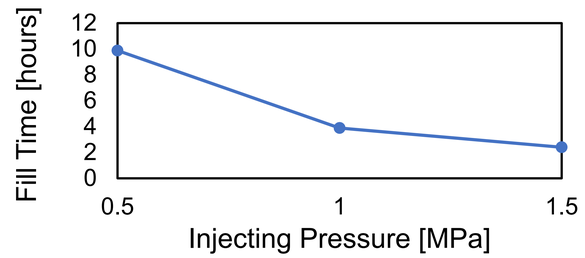
- Software Liquid Injection Molding Simulations (LIMS) to solve the finite element/control volume simulation of the connected pore filling.
- Numerical mesh is generated from CT images of physical samples.

Sensitivity Study on Injecting Pressure

First study: filled pores with constant viscosity and limit on fill time.



Second study: fill time with viscosity changing over time.



Acknowledgements

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