

Carbon Foam Research Report: Phys 200

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Goal: Our goal this quarter was to determine how to create a functional carbon foam out of hand-made bread that could potentially be used as insulation in the ISEC devices. As well, we wanted to experiment with varying bread compositions and analyze their effect on the thermal insulating properties of the carbon foams.

The Bread-making Process: Bread porosity is incredibly important when creating a thermally-insulating carbon foam. One way to obtain highly-porous bread is outlined in “Multifunctional Stiff Carbon Foam Derived from Bread.” In this study, researchers dissolved dry yeast in water by stirring, kneaded flour into the mixture, fermented this paste at about 35 C for 60 minutes, and baked it at 180 C for 40 minutes (Ye 16853). We followed a very similar procedure, fermenting our bread at roughly 100 F for 60 minutes and baking it at 350 F. As well, we experimented with a number of bread recipes containing varying amounts of a leavening agent, either active dry yeast or baking powder. Data on these recipes is contained in the table below.

Name of Bread	Flour type	Leavening Agent	Flour mass (g)	Water mass (g)	Proof Time (min) (~100 F)	Baking Temperature (°F)	Notes
From Paper (Yang, et al.)	All purpose	dry yeast	311	161	60	350	had to add 46 ml of water and 11 g of flour to get dough to right consistency
1g yeast per 100g flour	All purpose	dry yeast	300	225	60	350	I also had to up the water to get the consistency right, although I have less of a concept of what that is
1.5g yeast per 100g flour	All purpose	dry yeast	300	158	60	350	
.5g yeast per 100g flour	All purpose	dry yeast	300	225	60	350	
2 g yeast per 100 g flour	All purpose	dry yeast	300	165			
1g baking powder per 100g flour	All purpose	baking powder	300	226	60	350	
1.5g baking powder per 100 g flour	All purpose	baking powder	300	195	60	350	
2 g baking powder per 100 g flour	all purpose	baking powder	300	200	60	350	
0.5 g baking powder per 100 g flour	all purpose	baking powder	300	200	60	350	
5g yeast per 100g flour	all purpose	dry yeast	300	225			
7g yeast per 100g flour	all purpose	dry yeast	307	200	60	350	

Figure 1: Composition of bread loaves that were pyrolyzed.

Pyrolyzing Our Samples: The process we used to pyrolyze our samples closely followed that used by researchers in the study mentioned above. We tightly wrapped each sample in five or more sheets of aluminum foil and began heating our oven. We placed one to two loaves of wrapped bread in the oven once it reached >350 C, continued heating till 500 C, and maintained this temperature until no more visible smoke left the oven.

We then turned off the oven and left the pyrolyzed loaves to cool in the oven overnight. Below are pictures of some of our samples after being pyrolyzed.



Figure 2: Pyrolyzed loaves of bread.

Findings: We found that a loaf of bread made from 300-400g of flour typically takes between 2.5-3.5 hours to completely pyrolyze. As well, we noticed that loaves leavened with yeast instead of baking powder and those with higher ratios of yeast to flour tended to be less brittle. As you can see above, the loaf furthest to the left was made from baking powder and broke into multiple pieces shortly after being pyrolyzed. The loaves to the right were both made from yeast. However, this was simply a visual and tactile observation (after we had cut samples down for testing and observed some to be more cracked than others) and we have no data to back up this finding.

Unfortunately, we were not able to obtain much data about the thermal properties of our carbon foams because we were calibrating our measuring device during the majority of this quarter. We did manage to test one sample but part of our measuring device failed during this test, so it was inconclusive.

Citations:

Ye, Yuan, et al. "Multifunctional Stiff Carbon Foam Derived from Bread." *ACS Applied Materials & Interfaces*, vol. 8, no. 26, American Chemical Society, Jun. 2016,
www.researchgate.net/publication/303952391_Multifunctional_Stiff_Carbon_Foam_Derived_from_Bread/stats.