U.S. DEPARTMENT OF ENERGY

PNNL-19936

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Gleen Glass Swarf Research

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April 2010

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Pacific Northwest National Laboratory
Richland, Washington 99352

Objective:

John Sauer, Gleenglass principal, asked for research into innovative uses for a reclaimed glass slurry, also referred to as swarf. Through our research we were to determine a product and a market that could be manufactured using this fully recycled glass swarf.

Background:

Mr. Sauer receives the swarf from major glass manufacturers as a fine powder glass suspended in an organic dispersant and water. The swarf is produced through an industrial glass cutting process that results in the glass powder dispersed in water and recyclable glass disks; both are used in the project. Mr. Sauer's swarf studio testing has yet to produce any product with a value great enough to justify processing the swarf. Many of these limitations were believed to be due to the unknown composition and characteristics of the swarf as well as the limited lab testing ability of Mr. Sauer in his studio space.

Deliverables:

1. The valuable characteristics of the swarf.
2. Products that can be produced with the swarf.
3. Market for developed products.
4. Capital investment needed to create developed product.
5. Any other applications of the swarf that were outside of the scope of residential and commercial building material for use in future DOE grant proposals and proposals to the glass manufacturing facilities.
6. Additives that could change the color of the final piece to white, gray, or green.

Testing:

The presence of an organic binder and small particle sizes in the swarf appeared to make it an ideal candidate for foaming. Initially the swarf was inserted into a hot furnace between 1000°C and 1150°C to observe any foaming characteristics that may be possible using a continuous tunnel furnace. Various compositions were created using clean glass cullet, kaolin, sodium bicarbonate, and lithium carbonate in an attempt to control the pore sizes and create a uniformly white sheet.

Current facility constraints limit Mr. Sauer to temperatures under 1000°C and dictate the material must start and end cold. These kilns will also handle a maximum heating and cooling rate of 180°C/ hour. Experiments were performed within these constraints to

examine the foaming characteristics that may be possible as well as the pore structure, color, and strength.

Results:

The initial foaming tests produced a heterogenous foam that was not suitable for any applications with the exception of insulation. This foam also had a strong sulfur smell which needed to be removed before the foam could be used in any applications. Through different heat treatments and compositional changes a foam was created that had reasonably uniform pore sizes and a lack of the strong sulfur smell. The following conditions produced that result:

- Completely removing water from the swarf
- 2 Minute vibratory milling of the swarf to homogenize and reduce particle size.
- Adding between 10 and 30 wt% of another component, such as powdered glass cullet or kaolin, reduced the sulfur odor.

This composition produced an equally homogeneous foam when using the following heating schedule:

28°C to 850°C @180°C/hr
12 minute hold
850°C to 28°C @180°C/hr

Through careful examination of the foam, current markets, and product possibilities it is recommended that the foamed glass sheets be used for rooftop mulch applications as a replacement for rock. The porosity of the foam will offer excellent insulating properties for the roof and the light color won't absorb sunlight in the same way tar and rocks will. The foam has a much lower density than stone or rock as well, so it will relieve some structural stress added by the weight of rooftop rocks. The insulative properties of the glass, combined with the lack of sunlight absorption, make it a likely candidate to reduce the energy required to maintain the building temperature. It is also possible to cover this foamed glass material with soil to increase the drainage of the roof without significantly increasing the weight. The foamed glass rooftop mulch will also qualify for points towards LEED certification which will allow Mr. Sauer to build in a price premium into his product.

Appendix

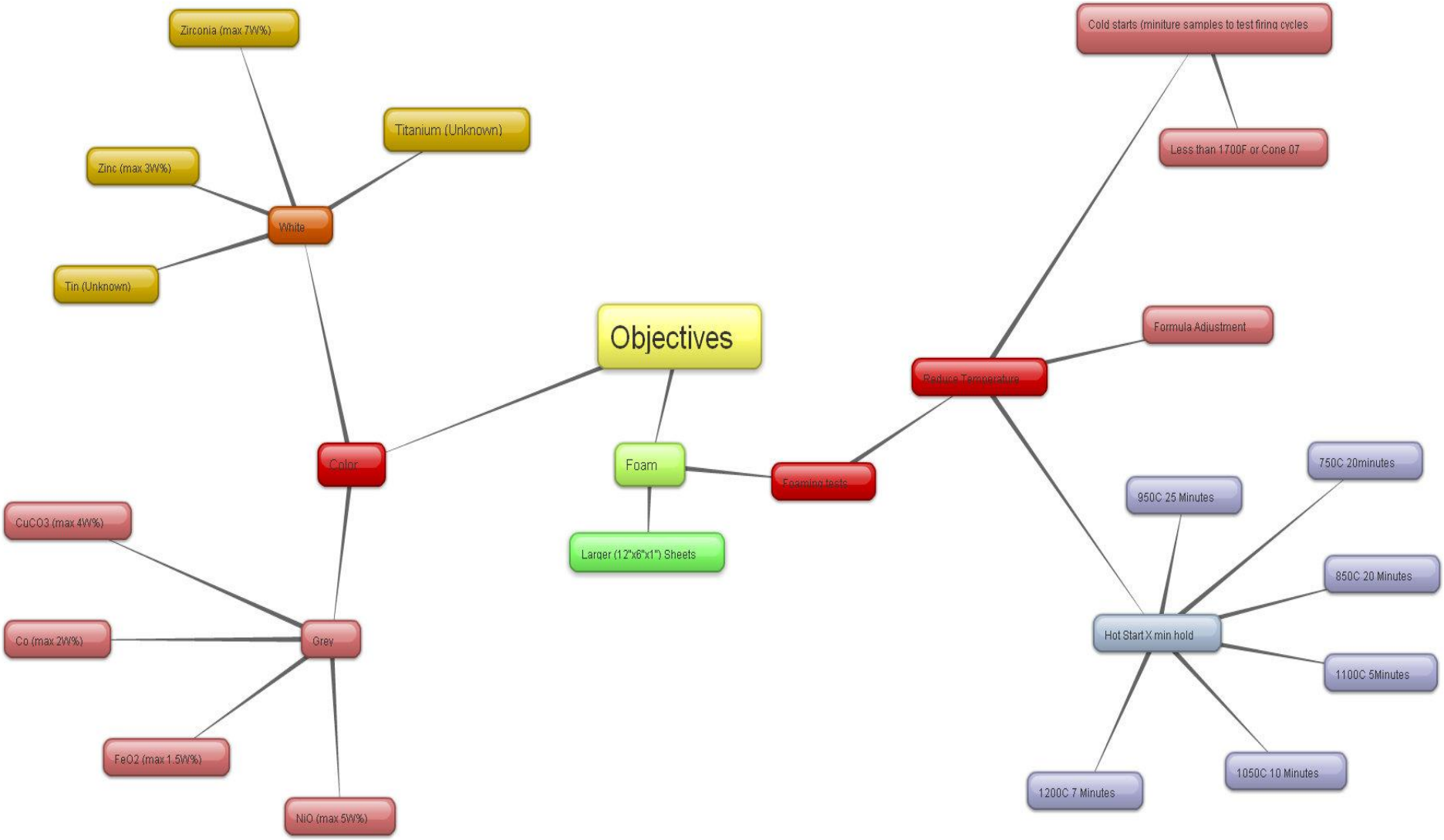

Figure 1. Brainstorming map on swarf testing.

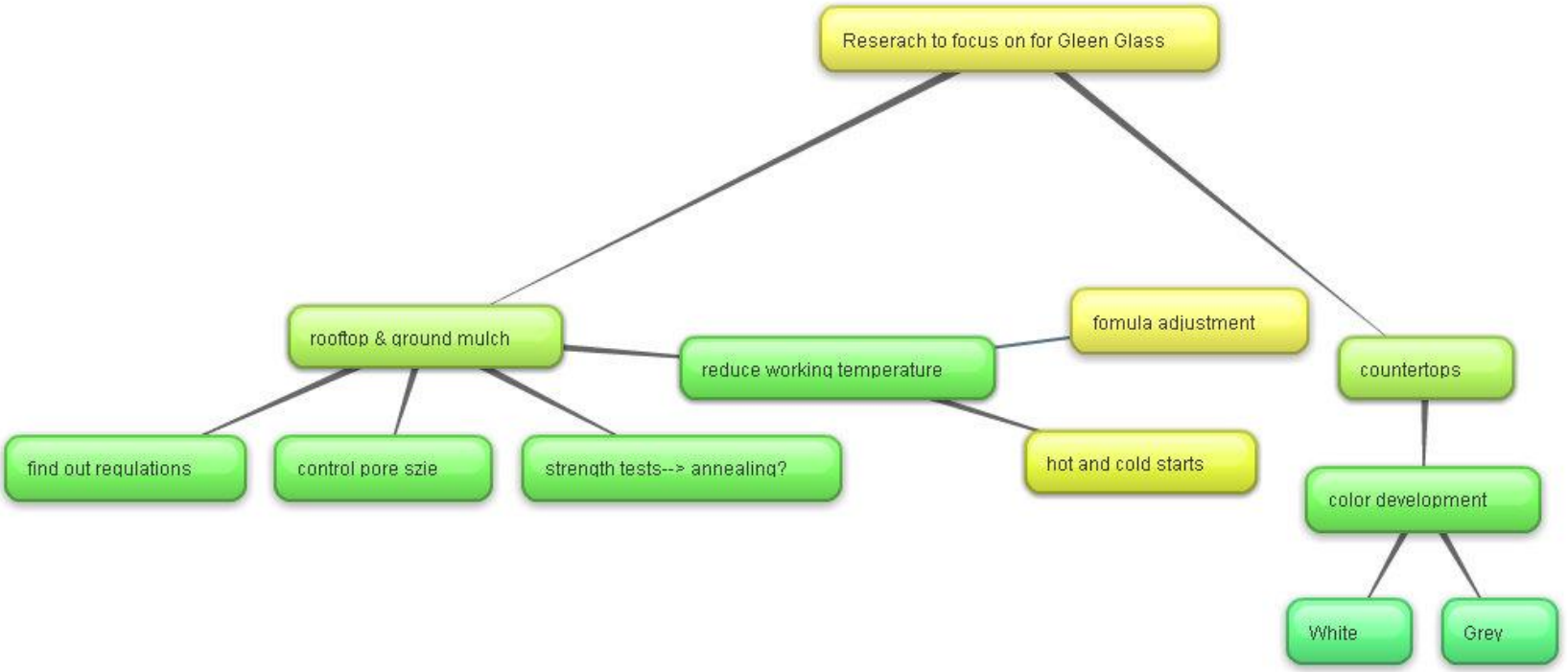

Figure 2. Product specific research track.

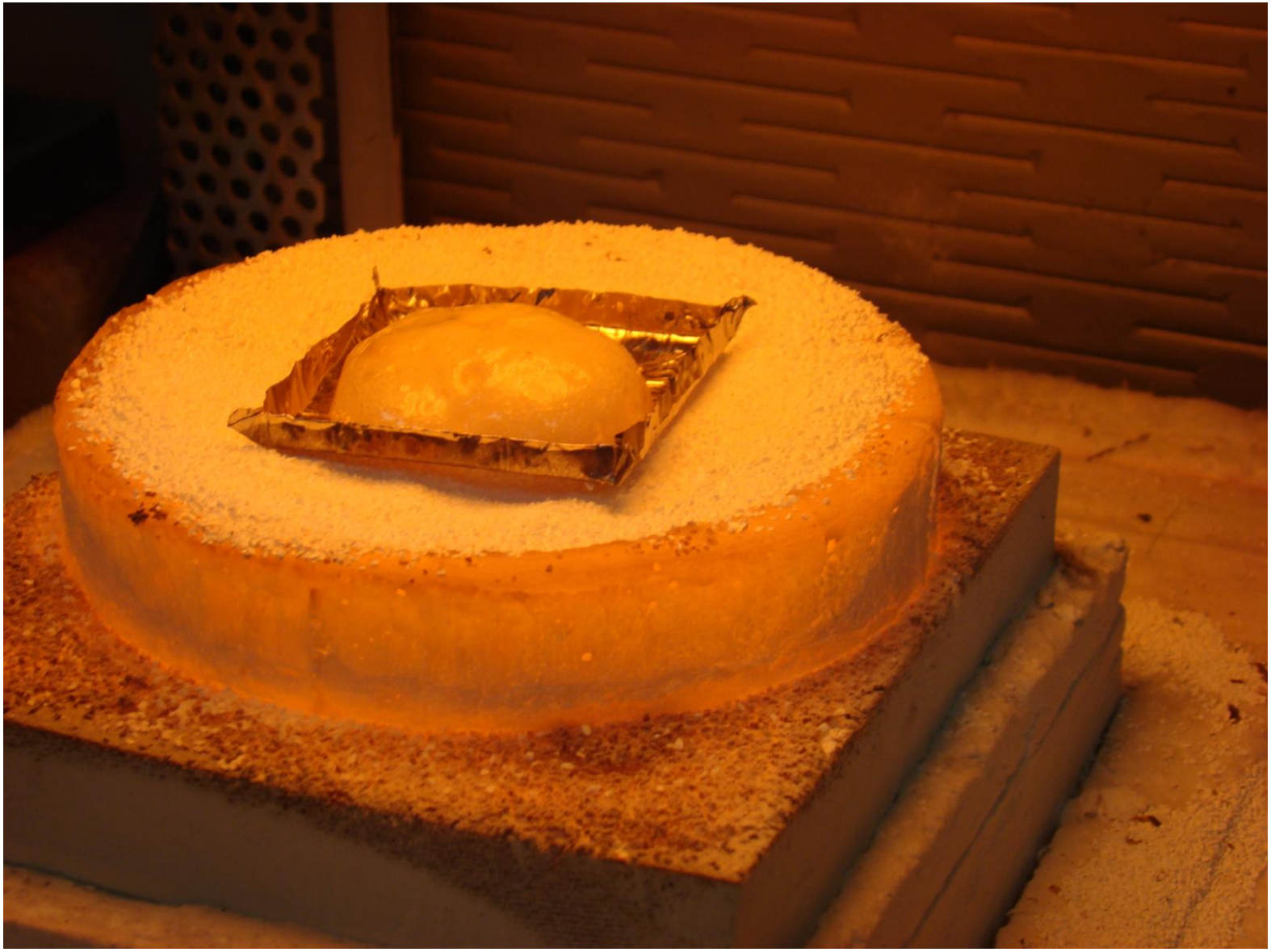

Figure 3. Image of swarf foaming in the furnace.