Technology Brief

COLOR MODIFICATION OF POST-CONSUMER GLASS CULLET

Modifying the color of recycled container glass could help to make recycled glass a viable raw material for hot glass operations. The Recycling Technology Assistance Partnership conducted a technology validation project in 1995 to demonstrate that by re-melting brown and green cullet and modifying its chemistry, a broad range of colors can be produced.

An initial series of small laboratory melts were conducted to test available methods of color modification. Properties of recycled glasses and previously tested methods of color modification were then reviewed by a panel of business, market, and technical experts to establish testing priorities for prototype melts. In the course of the project, formulas were tested and modified to produce nine transparent colors, two blacks, and a variety of opals using green, brown and clear bottle cullet. It is important to note the conditions under which these colors were produced, as resultant colors will vary widely depending on the source of glass cullet, furnace conditions, and the types of batch chemicals added.

Decolorization

At a certain level of zinc oxide, test trials have shown that *brown* bottle glass can be decolorized to a nearly colorless, neutral blue/green hued glass.

Key Words

Materials:	Post-consumer container glass.
Technologies:	Color modification chemistry.
Applications:	Cast and pressed glass products.
Market Goals:	Increased access to local, value-added markets.
Abstract:	Testing of selected techniques for chemically modifying the color of recycled glass used in the manufacture of decorative tiles.

Erbium oxide (Er_2O_3) and manganese oxide (Mn_2O_3) may be added to balance the faint blue/green hue. Melting *green* bottle cullet with 0.05% Mn_2O_3 yields a neutral smoky gray glass. From these base glasses, other colors can be produced with some of the common oxide colorants, such as cobalt, manganese, titanium, and copper.

Test Results

A total of 45 separate prototype melts were conducted in an effort to produce thirteen target colors identified by the advisory panel. Of the thirteen colors, formulations were successfully developed for five. These formulations are listed on the back of this fact sheet.

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Target Color	Grape Purple	Amethyst	Honey Amber	Swimpool Blue	Yellow Green
Clear Cullet (%)	60.5%	63.8%	---	79.8%	71.4%
Green Cullet (%)	20.2%	21.3%	---	---	---
Brown Cullet (%)	---	---	96.3%	---	---
Melt Temp	2400°F	2420°F	2350°F	2400°F	2500°F
Work Temp	2180°F	2190°F	2250°F	2250°F	2280°F
Melt Atmosphere	Oxidation	Oxidation	Neutral	Oxidation	Neutral
Borax	16.4%	8.2%	8.2%	16.0%	6.85%
Zinc Oxide	3.0%	3.0%	0.75%	5.0%	
Potash	8.8%	8.8%		8.8%	22.1%
Manganese Dioxide	0.55%	0.385%			2.5%
Cerium Oxide	1.0%	1.0%		0.7%	
Cobalt Carbonate	0.032%	0.016%			
Sodium Nitrate	0.66%	0.462%			7.5%

Experimental Procedure

Bottle cullet was pre-crushed with a hand crusher to a size of two inches minus and washed. Ceramics, metals, lead wrappers, and some plastics were also removed, but paper was left in the cullet.

Colorants and fluorine-based opacifiers were sourced from local suppliers. Fluxing agents were added to the formulations both to aid in melting the base glasses and to keep the colorants in solution.

Gobs of each glass were pressed in a hand-press using a patterned four-inch square tile mold.

Test trials indicated that the formulas above yield relatively consistent and satisfactory transparent colors. Additional research is required to identify methods of further decolorizing green bottle cullet to produce lighter colors with this base glass.

Test trials failed to produce consistent opal glasses. Opalizing agents (fluorine-based) were difficult to blend, and separated in the melt. This problem was exacerbated by the fact that the fluorine tended to volitilize during the melting process. Several attempts were made to improve the melt conditions and arrive at appropriate fluorine concentrations. The best results were obtained using a 150 to 200 mesh pulverized glass sand as a feedstock, and a shortened melt time. If these adjustments are made, it should be possible to obtain a whole set of opal colors from recycled glass.

Note: The protocol summarized in this Technology Brief assumes working knowledge of glass chemistry.

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For More Information

For a copy of the full protocol, Color Modification of Post-Consumer Glass Cullet (GL-96-4), use the CWC Publication Order Form. If you need more information call CWC at (206) 443-7746, email info@cwc.org or visit the CWC Internet Website at www.cwc.org.

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