



Best Practices in Glass Recycling

Fusing Recycled Glass

Material: Recycled Glass

Issue: *It is very simple to fuse recycled container glass to make tiles and relief plaques. However, information on raw material characteristics, temperature profiles, and operational issues has not been widely disseminated.*

Best Practice: At temperatures considerably below melting, particles of metal, ceramics, or glass begin to bond through a process called sintering. Sintering of soda-lime glass begins at about 1250°F. Sintering can be used to create solid glass objects by heating glass particles to above the sintering point and holding at that temperature until a dense body forms.

The basic steps are described below:

- 1) Obtain a mold that will withstand temperatures of at least 1600°F. For instructions on casting permanent molds, see *Permanent Molds for Fusing Glass* Best Practice. Coat the mold with a release. Commercial “shelf paints” are available. A mixture of 40% kaolin and 60% alumina hydrate also works well.
- 2) Fill the mold with glass pieces. Glass of any size can be used. However, the most consistent success has been obtained with glass that has been crushed to a uniform shape and screened to a size 16 mesh and finer. There is a trade-off here between glass grain size and cleanliness. It is easier to obtain a glassy, translucent product with larger grain sizes, but smaller grain sizes minimize contamination.
- 3) Fire the kiln to fusing temperatures. For green or amber container glass, the following schedule is a place to start:

500F/hour	to 1100F	(organic contamination should be gone by this point)
500F/hour	to 1600F	(or go as fast as the kiln will rise)
soak 5 minutes	at 1600F	(this is the critical time & temp – experiment)
Natural cooling	to 1020F	
Soak 15 minutes	at 1020F	(may need longer soak for thick or uneven pieces)
70F/hour	to 950F	
Cool 300F/hour	to 250F	
Open kiln to cool to ambient		

Each kiln acts differently. The maximum temperature that works best in a particular kiln may be anywhere from 1500 to 1600F. Fusing can also be done in cone kilns. Fire at maximum and try cone 010, 011, 012, and 013.

If the fused tiles have bubbles or bloat, it may mean that organics need more time to burn out. Try soaking at 1100F for 10 to 20 minutes.

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Container glass “devitrifies” very easily. This means that the glass changes from a glass back into a crystalline material, with two results: the glass takes on a matte finish; and it becomes much stiffer. Slower temperature profiles and long soaks appear to cause devitrification. A large amount of direct radiant heat (as from top-mounted heating elements) appears to promote devitrification, as well.

The best strategy for starting recycled glass fusing is to find a source of crushed glass that is reliable and consistent. Then develop a matrix for an experiment. Combine different colors and different grades, and fire with different ramping temperatures from 1450F to 1600F. Most of the early experiments will fail, but patience will be rewarded.

Either side of the fused glass product can be chosen as the featured side. The side exposed to the air will have a graceful “slump” and will probably be glossier than the other side. The side that was in the mold can be made to take on any type of relief.

Virtually any clean glass can be fused at the right kiln temperatures. However, “low-e” plate glass that is coated to reduce sun radiation into buildings has proven to be extremely problematic. The coatings are often metallic (zinc, tin, titanium, silver, chromium, and even gold are used), and are applied either as a “hardcoat” during the float glass manufacturing process, or as “sputter” coats on manufactured glass. Either way, although the coatings are only angstroms thick, they have been found to stay attached to the glass through crushing and screening operations, and to act as a barrier to fusing, even at relatively high fusing temperatures (over 1700F). If fused glass articles are found to be falling apart, it may be worthwhile to confirm that no coated glass is getting into the supply stream.

Implementation: These instructions can be used with the Best Practice *Permanent Molds for Fusing Glass* to begin experimenting with glass fusing.

Benefits: This process is accessible to anyone with a ceramics kiln capable of 1600°F.

Application Sites: Crafts shops, small businesses.

Contact: For more information about this Best Practice, contact CWC, (206) 443-7746, e-mail info@cw.org.

References:

Richerson, David W., *Modern Ceramic Engineering - Properties, Processing, and Use in Design*, Marcel Dekker, Inc., 1982.

For a general discussion of glass fusing and moldmaking:

Lundstrum, Boyce, *Glass Casting and Moldmaking*, Vitreous Press, 1989.

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