

Mosaic glass ceramic from recycled glass

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Introduction

Industry of glass in Egypt relied on high manual skills which has been used in glass formation, coloring and decoration. Glass is one of the materials that doesn't decompose with time, so its wastes occupy a large space and can't get rid of them easily, hence the recycling process of glass has been so significant due to the extreme increase of wastes and their damaging effect on humans and the environment.

So it was necessary to figure out the best appropriate technical method to benefit from such wastes by recycling them, glass wastes were crushed and sieved, the powder was used in the production of mosaic from ceramic glass that can be employed in covering walls and decorating them internally and externally. That's how ceramic glass resulting from glass wastes is performing two functions one is aesthetical and the other is preserving the environment from accumulation of huge amounts of glass waste.

That's how the **research problem** appears:

- In lack of production of mosaic from ceramic glass produced from glass waste.

The research aim:

- Production of ceramic glass mosaic out of glass waste.

The research importance:

- The research paper has economic, aesthetical and functional significances.

In order to reach a solution for the problem, wastes of flat, embodied, transparent and colored glass were used and recycled.





Keywords: glass wastes- ceramic glass- mosaic


Steps for recycling process of glass waste to produce ceramic glass:

1- Collecting the required glass wastes.

The main materials used in preparation of commercial glass used in this research:					
As a source for sodium oxide Na ₂ O	Soda ash	As a source for calcium oxide CaO	Limestone	As a source for silicon oxide SiO ₂	Sand
		As a source for magnesium oxide MgO	Dolomites	As a source for aluminum oxide Al ₂ O ₃	Feldspar
Other secondary materials added with low amounts as glass coloring materials					
For hazel color Fe ₂ O ₃	Ferric oxide	For blue color CoO	Cobalt oxide	For green color Cr ₂ O ₃	Chromium oxide
Also calcium sulphate is used from gypsum CaSO ₄ ·2H ₂ O, as well as Na ₂ SO ₄ to help with the harmony of glass and collect gases and get rid of them.					

Table one clarifies the chemical composition for the various types of commercial glass that were used in the research

Composition Percentage) % weight(Glass type	The form
Fe ₂ O ₃	CoO	Cr ₂ O ₃	SiO ₂	MgO	CaO	Na ₂ O		
----	----	----	70-74	----	8-13	13-18	Table glass	
----	----	<0.1	70-74	----	8-13	13-18	Green glass	
----	<0.07	----	70-74	----	8-13	13-18	Blue glass	
	----	----	70-74	----	8-13	13-18	Brown glass	

----	----	----	~72	~4	~10	~14	Cars glass	
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Glass wastes were collected from various resources such as car glass alteration stores and contractors for collecting and sorting glass wastes.

2- Grinding the used glass wastes

The broken glass wastes were grinded using the grinding mixer with quartz balls (agate Balmily - Retch – Germany) in order to get a powder with cohesive granules and composition.



shape no. 4 shows broken glass in the glass grinder before its activation



shape no.5 shows glass powder after grinding.



shape no. 6 shows glass powder sift.



shape no. 7 shows 40 grams of glass powder

3- Glass waste powder formation

Glass powder is placed within an iron mold prepared for formation of the powder in the required form, for the preparation of these samples a rounded mold was used.

The powder is mixed with a little amount of polyvinyl alcohol (7%) to ensure the powder granules are cohesive together after pressing them.

Pressing the samples using a unidirectional hydraulic presser (Paul weber) at a pressure of 20 kilo Newton.



shape no. 8 shows a rounded iron model used in pressing the samples



shape no. 9 shows the addition of the polyvinyl alcohol (7%)



shape no. 10 shows placing the mold inside the hydraulic presser

4- Thermal processing of the formed glass

Samples were placed in thermal processing oven at 650- 700-750° c, for two hours for the process of sintering and thermal processing of the various glass samples.

Results of the lab experiments:

Temperature			Glass type
c750°	c700°	c650°	
			Car glass
			Blue glass
			Green glass







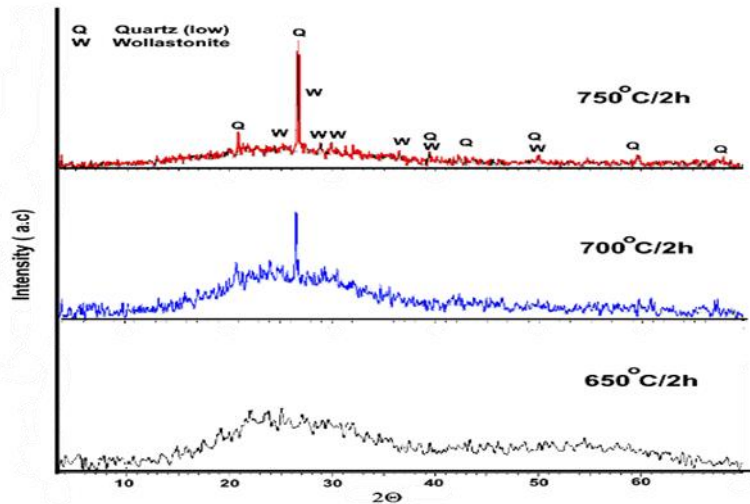
			Brown glass
			Table glass

Table 2 clarifies the samples after finishing the thermal treatment process



Shape (11) results of the deviation of x-ray of car glass sample at 650-700-750° c.

5- Density was measured using Archimedes method as the weight of the glass sample was measured in the air then the weight in a solution with known density to determine the volume (density=weight) gm/cm³, water is used with density = 1.

Weight in the air: W1

Weight in the solution (water): W2

Weight in the solution: W3

Density = $W1 / (W1 - W2) \times 1$, in case of water (water density=1)

Density = $W1 / (W1 - W3) \times$ in case of solution? (solution density)

Density	Weight in the water	Weight in the air	The sample
2.42	5.68	9.68	Blue ceramic glass of blue glass
2.45	5.78	9.76	Green ceramic glass of green glass
2.22	5.49	9.84	Gray ceramic glass of table glass
2.42	5.71	9.71	Brown ceramic glass of brown glass

Table 3 shows the ceramic glass samples used in measuring density and calculating the weight in air and water



Density was measured for 4 samples of ceramic glass:



Shape (12) shows glass samples that their densities were measured

Applied experiments:

Production of ceramic glass samples with various shapes by using iron molds with different sizes and forms.

<p>Cars broken glass –table broken glass –green color broken glass- blue color broken glass-brown color broken glass</p>	<p>The used materials</p>
<p>Iron molds of various forms and sizes</p>  <p>Form</p> <p>Clarify hexagonal mold with two different sizes and round shape</p>	<p>The used materials</p>
<ol style="list-style-type: none"> 1. Cars and green color broken glass were grinded in glass grinder separately then were sifted as the previous experiments. 2. 15 gm of green glass powder and 55 grams of car glass powder were weighed. 3. Star shaped mold was placed in the center of the hexagonal mold then powder of the green color glass was placed first inside the star then pressed. 4. Car glass powder was distributed outside the star and was firmly pressed. 5. The star mold was lifted and glass powder was pressed firmly using the hydraulic presser. 6. The sample was extracted of the mold and placed inside the oven for 2 hours at 750° c for its thermal processing.  <p>Forms (17) (18) (19) (16)</p> <p>Clarify the star shaped mold at the center of the hexagonal mold and the glass powder is placed inside.</p> <p>Car glass powder was places outside the star mold and pressed then the star shaped mold was removed for pressing again.</p>	<p>Steps</p>



Form (20)

Clarifies the result of the sample after thermal processing.

Results

- 1- Production of ceramic glass samples with various forms and colors of glass wastes powder and density was measured with its x-ray deviation.
- 2- Preservation of the environment from accumulation of glass wastes and using them in production of ceramic glass of multiuse.

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