High mechanical resistance glass ceramics based on polishing ceramic, glass and fly ash wastes

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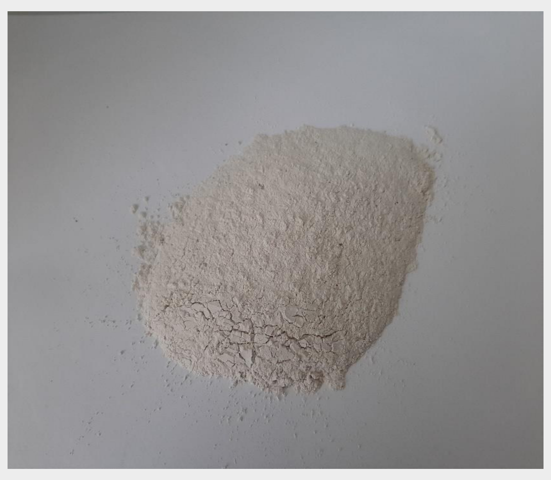
1. Introduction

Over the last few years, the concept of Circular Economy has become the worldwide attention as a procedure to optimize the natural resources, energy and waste with special focus on urban and industrial residues [1,2]. A large quantity of industrial wastes are produced during manufacture processes. The wastes carries thoughtful environmental problems. The global tendency of environmental legislation claims upon the approval of cleaner manufacture performs in industrial practises, allowing for the environmental effects throughout the life cycle of products [3].

Glass wastes

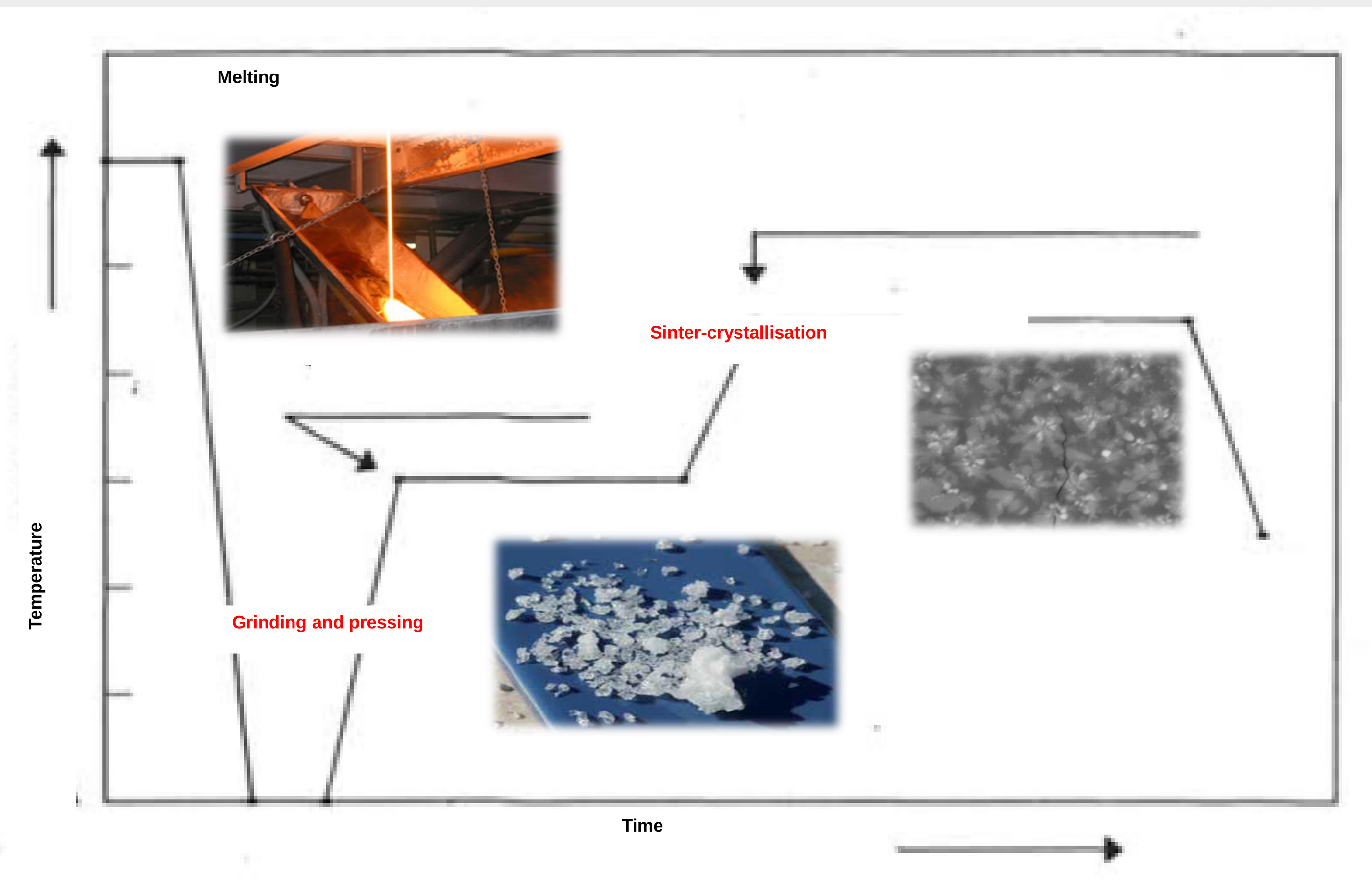


Ceramic polishing

Fly ashes

2. Methodology

The synthesis of a new glass-ceramics obtained by sinter-crystallization method have been investigated by using ceramic polishing, soda-lime-silicate glass and fly ashes wastes. Chemical compositions of wastes and glass-ceramic samples were studied by X-ray fluorescence (XRF). Structural characterization by X-ray diffraction (XRD) measurement revealed the crystalline phases depending on process parameters. The morphology and microstructure of glass ceramics were characterized by scanning electron microscopy (SEM/EDX).. The experimental compositions allowed reutilizing residues to produce high mechanical resistance glass ceramic substrates with suitable properties and environmental profits.



3. Results and discussion

Table 1. XRF Analysis of the wastes.

Wt%	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	K_2O	CaO	TiO_2	SO_3	Fe_2O_3	LOI
Glass waste	12,59	3,75	0,85	73,16	0,01	0,30	8,94	0,05	0,20	0,10	0,10
Fly ash	0,20	1,23	26,63	44,44	0,41	1,23	5,53	0,92	0,72	18,43	0,15
Ceramic Polishing	3,49	0,73	20,13	67,80	0,00	0,10	2,29	3,97	0,00	0,01	1,47

Table 2. XRF Analysis of the glass ceramic composition.

Wt%	Na_2O	MgO	Al_2O_3	SiO_2	K_2O	CaO	TiO_2	Fe_2O_3	LOI
COMPOSITION	6,83	2.10	17.05	52.75	0.78	12.34	0.36	7.69	0.05

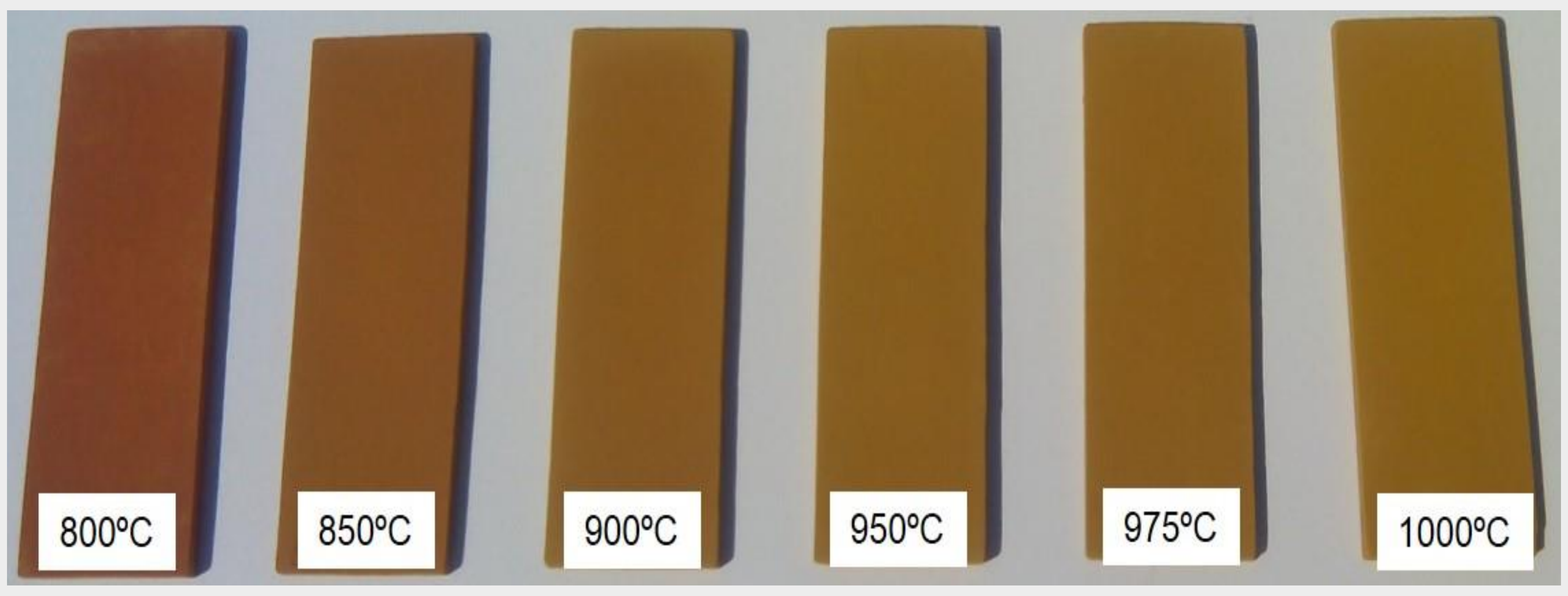


Figure 1. Images of glass ceramic samples after thermal treatment at a) 800ºC, b) 850ºC, c) 950ºC, d) 975ºC and e) 1000ºC

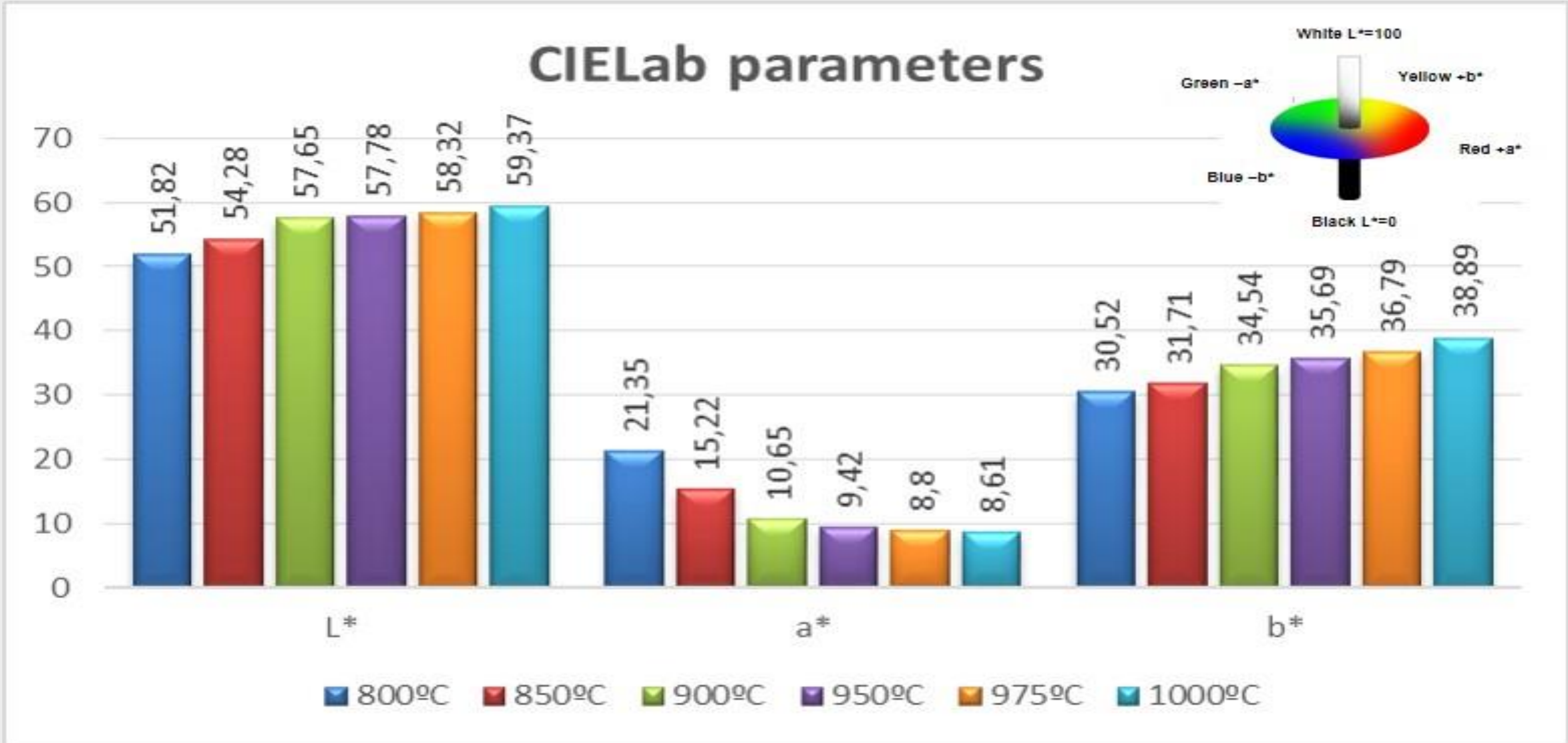


Figure 2. CIELab parameters

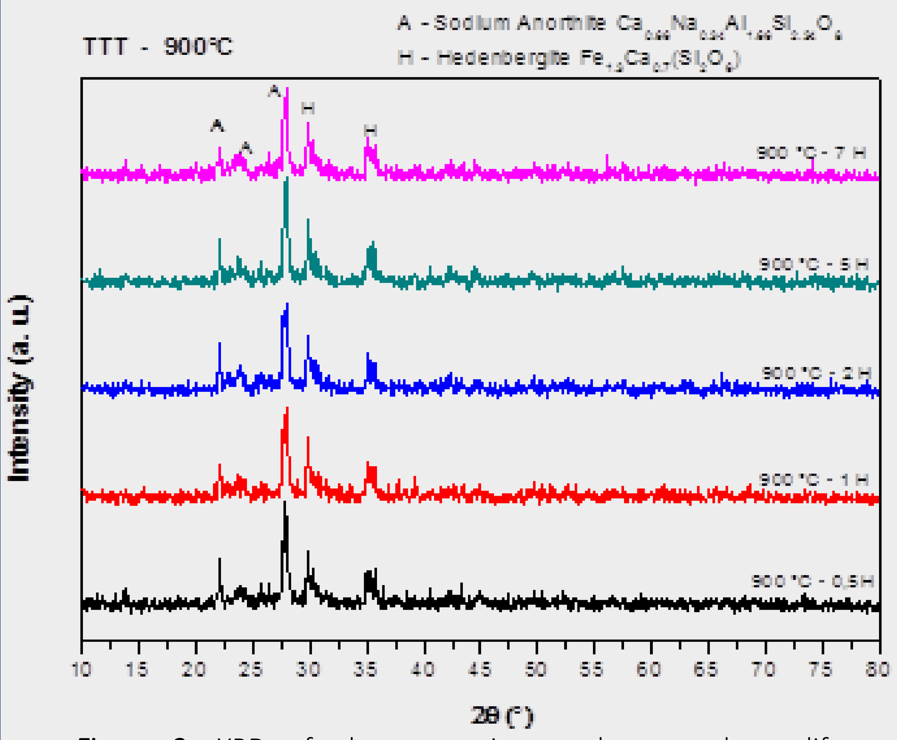


Figure 3. XRD of glass ceramic sample treated at diferent temperatures

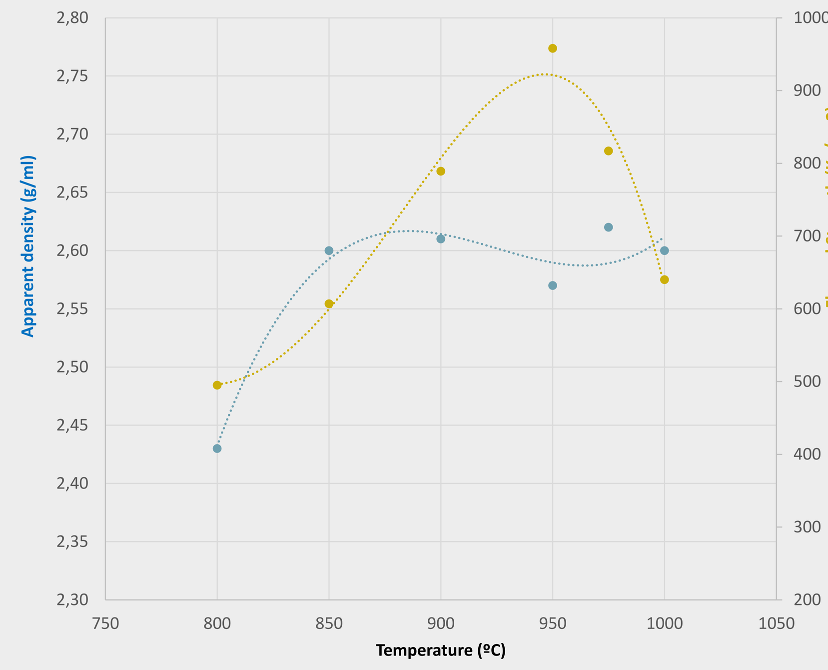


Figure 4. Aparent density and flexural strenght measurements.

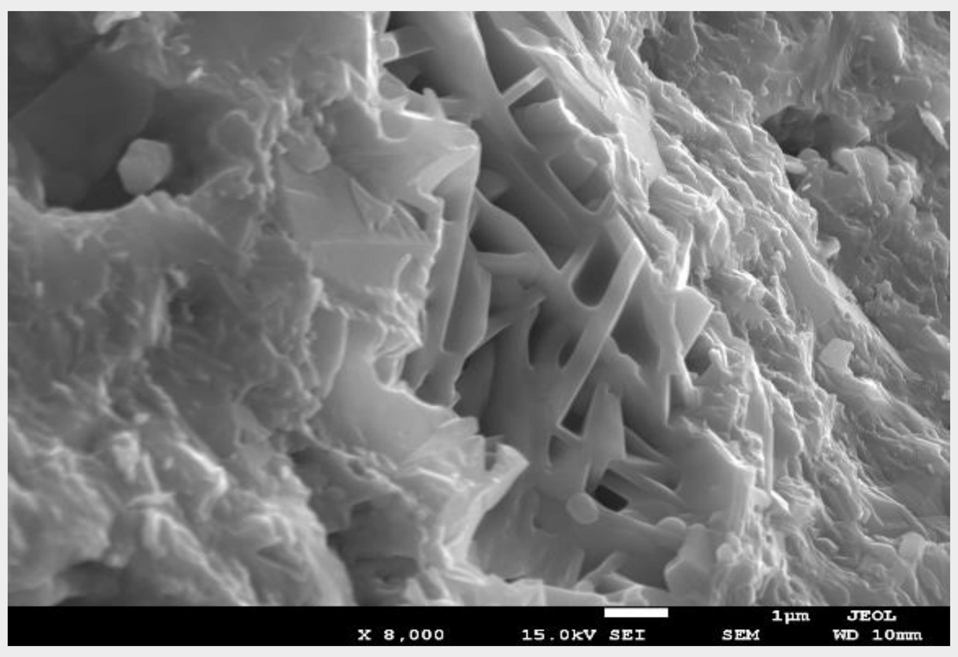


Figure 5. SEM micrograph of glass ceramic sample treated at 950ºC.

The X-ray diffraction spectra of glass-ceramic treated at 950ºC are exposed in Figure 3. The main diffraction peaks of sample could be assigned to sodium anorthite (JCPDS 86-1650) and hedenbergite phases (JCPDS 70-1876) demonstrating the viability of the vitrification process.

Figure 4 shows density values with a maximum value (2.60 g/cm3) is reached 850ºC, been more or less constant until 1000ºC. The flexural strength increases with temperature, achieving the maximum (around 95MPa) at 950ºC when the hedenbergite shows the higher value.

SEM micrograph (Figure 5) exhibit the presence of crystals inside the sintered particles. The average chemical analysis by EDX of the crystals in these crystallized samples shows the following oxides: 6.0 wt% Na2O, 0.9 wt% MgO, 15.5 wt% Al2O3, 61.2 wt% SiO2, 0.8 wt% K2O, 8.8 wt%, CaO, 6.7 wt% Fe2O3, showing that there is a mixture of both phases, the sodium anorthite, and the hedenbergite

4. Conclusions

It has been obtained a high-resistance glass-ceramic tile formulated from industrial residues (glass, fly ash and ceramic polishing), which exhibits better technological properties (2.60g/cm3 apparent density and 95MPa flexural strength) than conventional porcelainized stoneware tiles

5. Acknowledgment

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6. References

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