Layered glass-ceramics as a new solution for the valorization of inorganic waste

Glass-ceramics based on iron-rich waste (slag from nonferrous metallurgy: $SiO_2/Al_2O_3/FeO/CaO/ZnO=24/6/32/21/7$, by wt%) were manufactured by following an innovative approach, combining direct sintering and sintercrystallization processes. According to this method, a layered tile was manufactured by single firing (Fig.1-2), at 900°C, using selected combinations of wastes for both porous body and dense coating layer ("glaze"). The body derived from a mixture comprising 50wt% soda-lime glass and 50% waste (granules with maximum diameter of 150 μ m). The glaze resulted from a glass frit, in turn obtained by melting a mixture comprising 75wt% soda-lime glass and 25% waste, undergoing sinter-crystallization, mixed with zircon and recycled borosilicate glass powders (diameter <63 μm). The glaze sealed the porosity of the body and enhanced both mechanical properties and chemical stability. A near-to-zero water absorption rate, despite a low geometric density (~2 g/cm3), was accompanied by a Young's modulus of ~40 GPa and a bending strength of ~30 MPa, so that the developed materials could find applications in the building industry as lightweight tiles. Vitrification of waste was sustainable, since it was applied only to a limited amount of the starting materials. The chemical stability of the new glass-ceramics was assessed by the application of a toxicity control leaching procedure (TCLP). Furthermore, cell culture tests indicated no potential cytotoxicity of the materials (Fig.3).

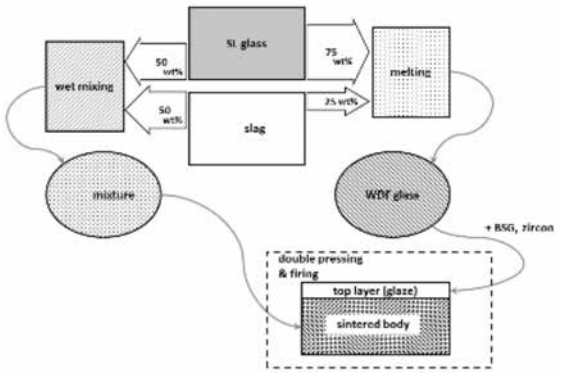

Fig. 1 - Schematic representation of the processes adopted for layered glass-ceramics

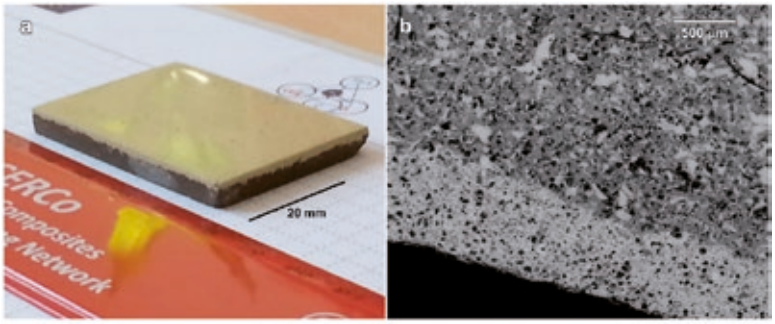

Fig. 2 -Details of a layered glass-ceramic: a) photographic view b) interface (SEM micrograph)

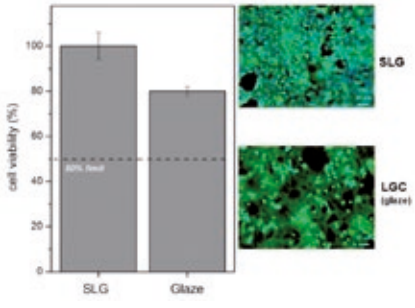

Fig. 3 - Cell viability (in %) referred to a commercial soda-lime glass (SLG) (left); fluorescent microscope images of samples from direct cytotoxicity test (right)

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Main research topics:

- Novel construction materials from inorganic waste and/or recycled glasses
- Monolithic and cellular glasses and glass-ceramics
- Nanostructured ceramic composites from preceramic polymers and fillers
- Advanced porous ceramic components
- 3D printing of ceramics
- Bioceramics from novel formulations and novel processing
- Porous geopolymers