# Reducing, recycling and reusing of construction and demolition wastes by the incorporation in the glasses


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**Abstract:** **Construction and demolition wastes occupy to the large storage spaces and cause pollution. Until now, the obtaining of the new products such as concrete and bricks was limited only to the addition of suitable binders contents, compaction and heat treatment, without to exist a concrete recycling method. In this paper, ten types of composites were prepared by an eco-innovative method including the following wastes in the crushed glasses: brick, autoclaved aerated concrete, plaster, mortar, lead, lime, iron (with varied contents), cast iron, ash. The prepared materials were characterized by the analysis of XRD and SEM, IR and UV-Vis spectroscopy. Our results show structural modifications in the silicate network, the processes of water absorption and electronic transitions of metallic ions. The composites can be used in the concrete industry with high quality due the presence of crystalline phases originated from waste with role in the water absorption process.**


## Motivation:

**i) The amount of construction and demolition waste occupy half of the total municipal solid waste,**

**ii) A general recycling technology do not exist;**

**iii) The recycling of construction and demolition wastes is realized only by sorting and crushing processes;**

**iv) The current approaches in the recycling of construction and demolition waste and the obtaining of new products are limited to the addition of suitable binder contents, compaction and heat treatment.**

**Experimental Procedure:** **The mixtures with the construction and demolition wastes were introduced in a corundum capsule which was placed on the magnetic stirrer at room temperature. A solution of NaOH : HCl = 1 : 1 (volume %) was added to the mixture over stirring. After 15 minutes a separation process of the glassy was observed. The water was evaporated at 100 °C and after that the temperature was increased gradually at 250 °C (depending on the nature of the construction and demolition waste) when a phenomenon of agglomeration of the sample were evidenced. The experimental procedure was repeated for the varied types of construction and demolition wastes: cast iron, iron, ash, brick, BCA, plaster, mortar, lead and lime. X-ray diffraction data were collected from the obtained samples using a Smart Lab Rigaku diffractometer with a graphite monochromator for the Cu-Kα radiation (λ = 1.54Å) at room temperature. The FT-IR spectra of the samples were obtained in the 350 - 4000 $cm^{-1}$ spectral range with a JASCO FTIR 6200 spectrometer. UV-Visible absorption spectra of the samples were recorded at room temperature in the 300 – 1100 nm range using a JASCO V-550UV/VIS spectrometer equipped with an integrating sphere.**

## Results and Discussion

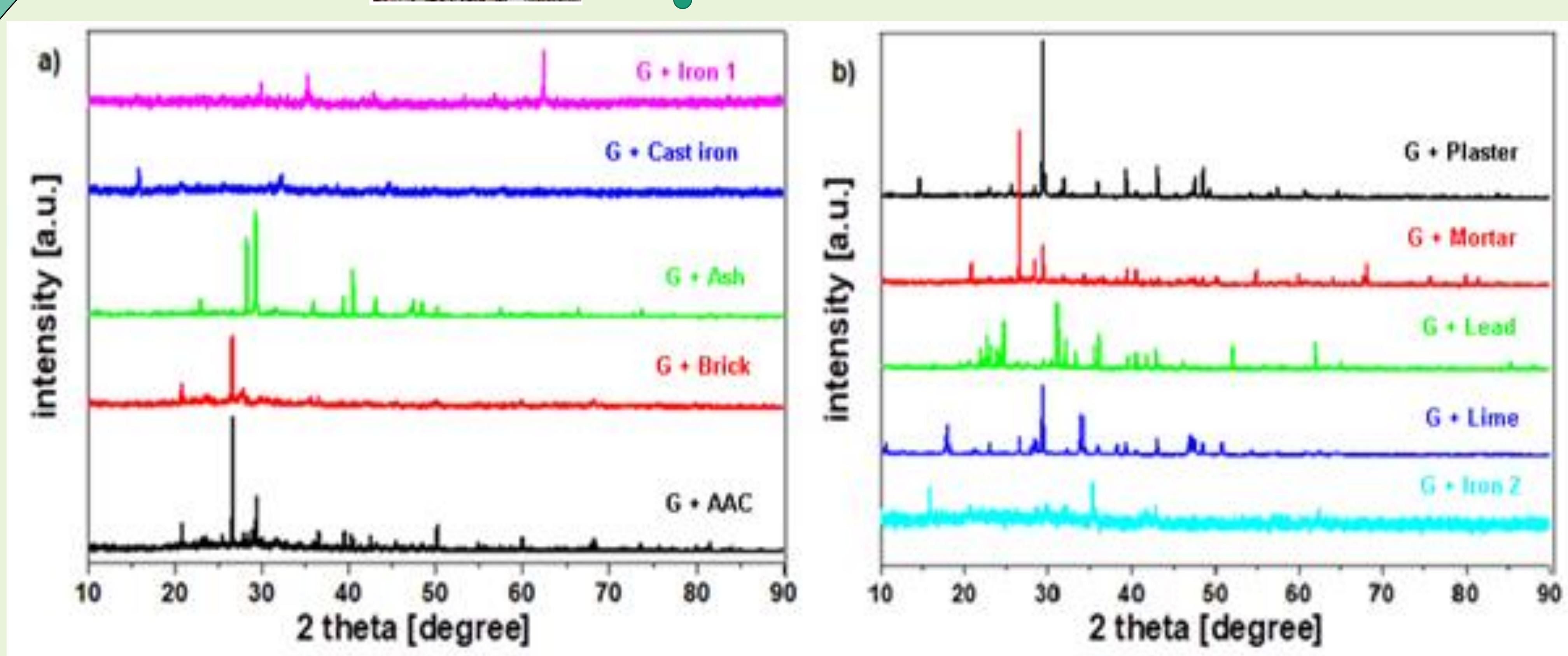


*Figure 1: X-ray patterns of prepared samples from construction and demolition wastes: glasses (G), autoclaved aerated concrete (AAC), ash, brick, ash, iron (with varied contents), cast iron, plaster, mortar, lead, lime.*

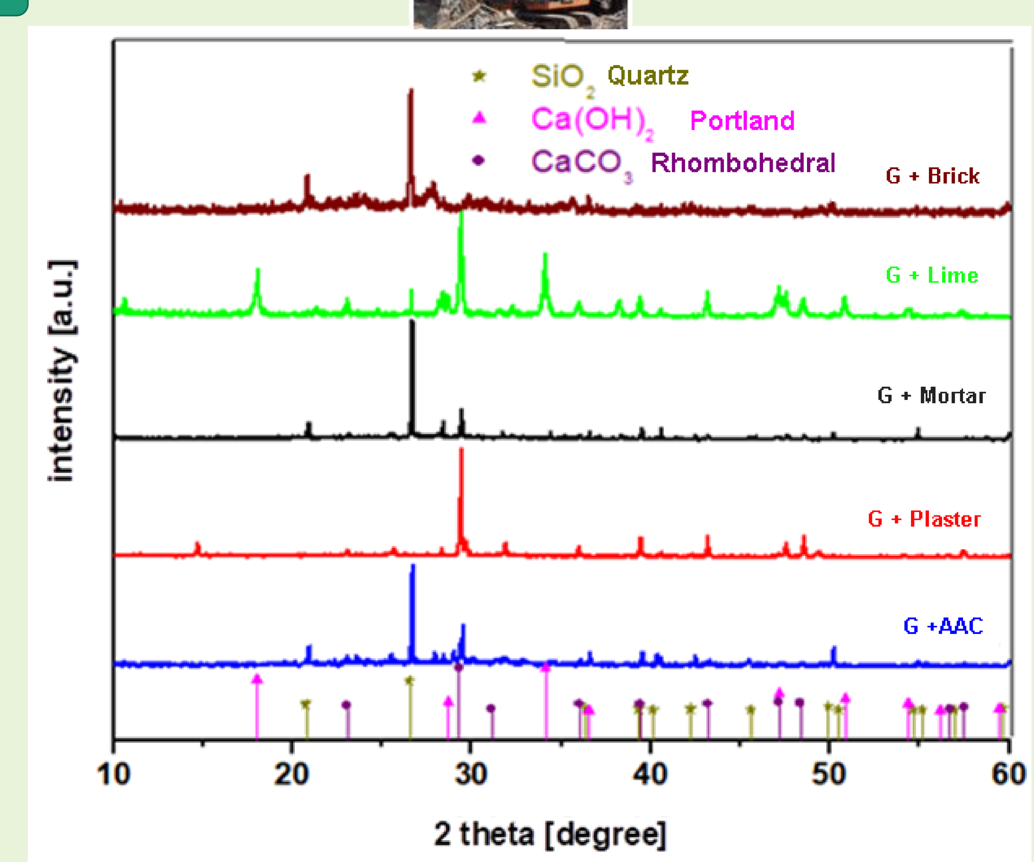


*Figure 2: X-ray diffractograms and the assignment of the diffraction peaks corresponding to the crystalline phases in composite materials containing AAC, plaster, brick, mortar, lime.*

**The analysis of X-ray diffraction data (*see Figures 1 and 2*) for the prepared samples indicates a vitroceramic structure (composite structure) with diffraction peaks characteristic of different types of crystalline phases. In the composite materials containing AAC, mortar and brick, the presence of silicon dioxide, $SiO_2$ crystalline phase with a quartz structure in the predominant amount. The formation of calcium carbonate, $CaCO_3$ in small quantities was also evidenced. In the composite materials containing plaster and lime the presence $CaCO_3$ crystalline phase as main phase was highlighted. Lime - doped glass ceramics consist of two main crystalline phases, namely $Ca(OH)_2$ (Portlandite type calcium hydroxide) which is the basic raw material for the preparation of cement and $CaCO_3$, respectively and in traces of $SiO_2$ crystalline phase with quartz structure.**

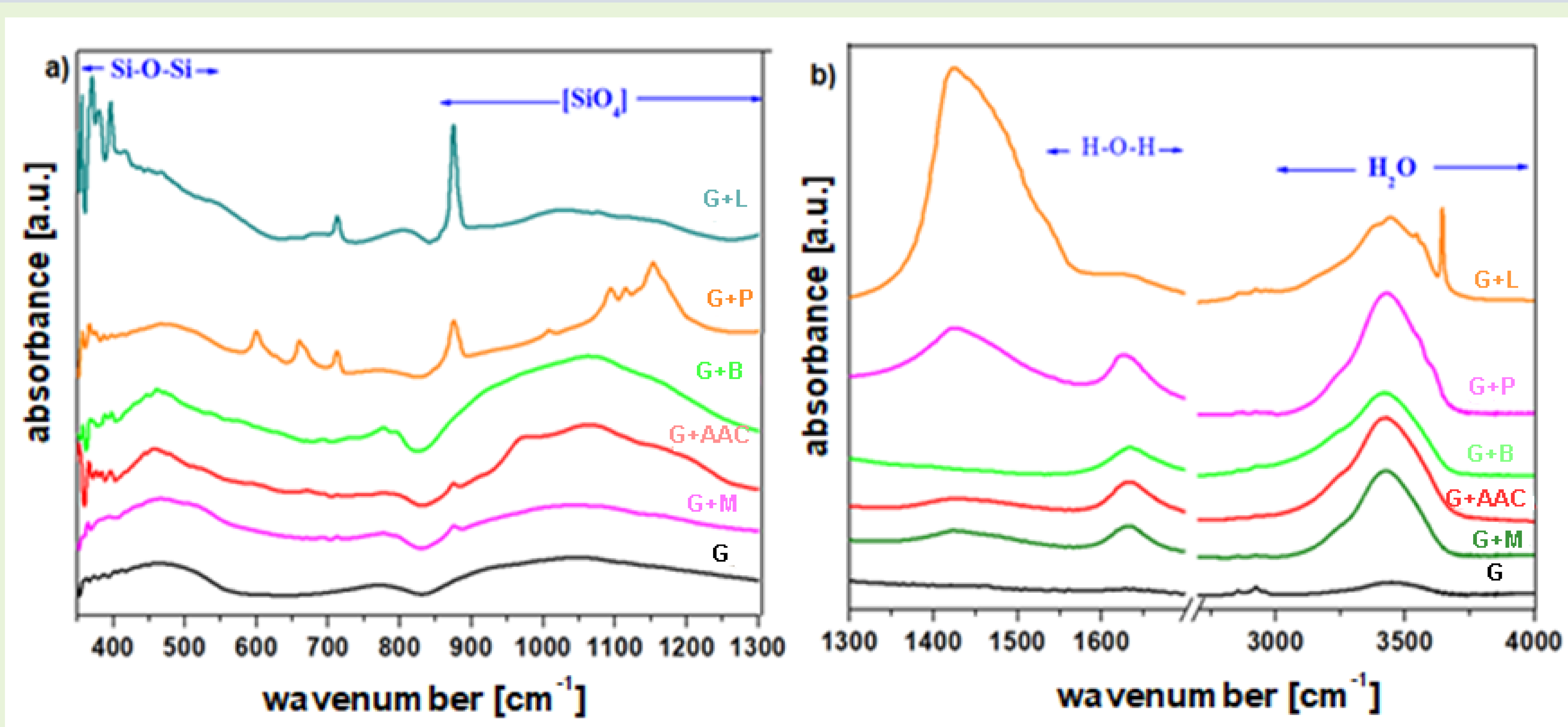


*Figure 3: FTIR spectra of composite materials prepared by the incorporating into glasses (G) of construction and demolition wastes: brick (B), autoclaved aerated concrete (AAC), plaster (P), mortar (M), lead (P) and lime (L) in the region between a) 350 - 1300 $cm^{-1}$ and b) 1300 - 4000 $cm^{-1}$.*

**A simple inspection of the FTIR spectra (*see Figure 3*) indicates wider absorption bands specific to the structural units of glassy network with amorphous structure consisting of $SiO_4$ (silicate) structural units but also narrow IR bands attributed to the structural units corresponding to the formation of crystalline phases provided to the construction and demolition wastes. The IR bands situated in the region with higher wave numbers respectively ~ 1600, 2950 and 3400 $cm^{-1}$ are due to water absorption. The intensity of the IR bands corresponding to the water absorption processes attains maximum values for the composite materials doped with lime and plaster. These structural evolutions show the applications in the cement industry.**

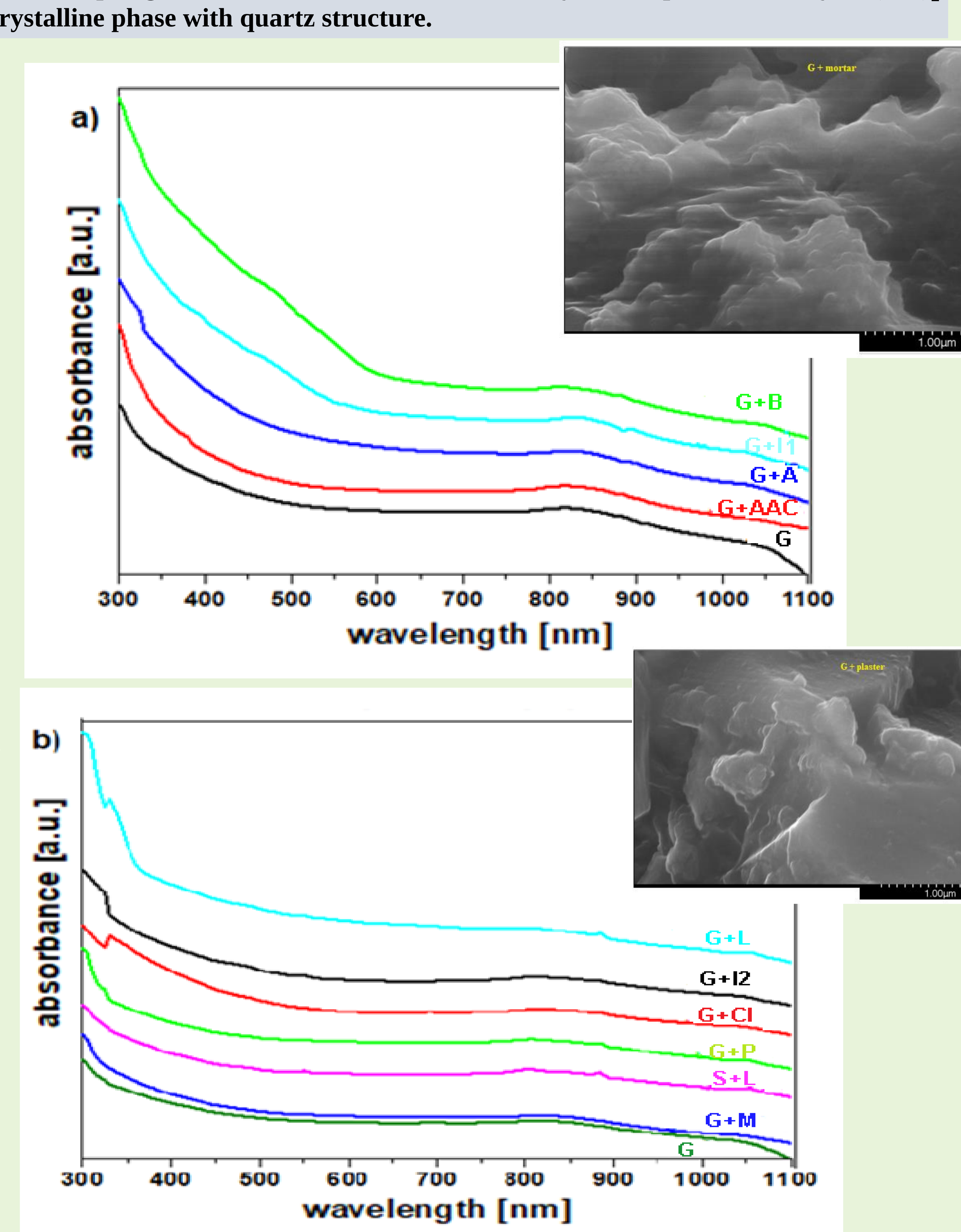


*Figure 4: UV-Vis spectra of composite materials prepared by the incorporating into glassy network (G) of varied construction and demolition wastes: iron (I), cast iron (CI), ash (A), brick (B), autoclaved aerated concrete (AAC), plaster (P), mortar (M), lead (S+L) and lime (L).*


*Figure 5: Photo and SEM Images of the composite materials prepared by the incorporating into glassy network (G) of varied construction and demolition wastes: ash, cast iron, iron (varied contents), brick, autoclaved aerated concrete (AAC), plaster , mortar and lime .*

**UV-Vis spectra of the composite materials (see Figure 4) indicate the electronic transitions of the metallic ions provided from the structure of the construction and demolition wastes.**

## Conclusions

**The composite samples were prepared using as raw materials the construction and demolition wastes and spent glasses. The composite materials were characterized by the X - ray diffraction, SEM, FTIR and UV-Vis spectroscopy. X-ray patterns show a vitroceramic structure for all samples. The analysis of the FTIR spectra indicate the stretching vibrations of Si-O bonds and the bending vibrations of the Si-O-Si angles originated from glassy host matrix, the structural units of the varied metallic ions (in agreement with UV-Vis data) and the IR bands due to the water absorption processes. Prepared composites have different colors and as result, may be further subject, to obtain pigments for the construction industry. In the structure of the composite materials were found $SiO_2$ crystalline phase with quartz structure and other crystalline phases from wastes with a role in water absorption. These superior characteristics of the composite materials offer the open of applications in the concrete and pigments industry.**


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