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Development of hybrid geopolymeric-based materials suitable for building sector

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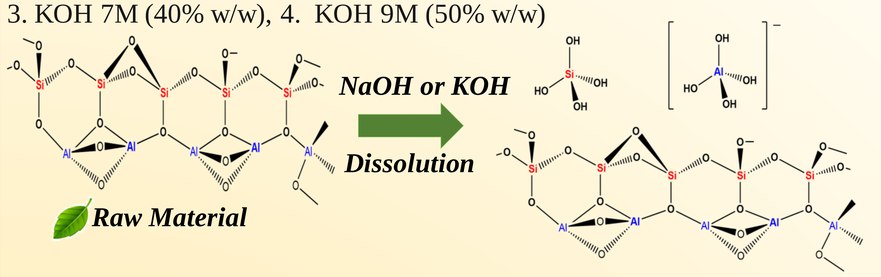
1. Introduction

The term "**geopolymer**" describes a wide variety of composite materials, natural or synthetic, having a polymeric structure. They are materials similar to ceramics, whose components are mainly **aluminium-natural silicates**, although this class of compounds can easily be extended to all inorganic polymers present in nature, such as phosphates (apatites), borates, vanadates, arsenates and waste. The geopolymerization takes place in three phases: dissolution of the aluminosilicate source, polycondensation of aluminosilicate oligomers and finally precipitation of geopolymeric particles, which form a gel [1]. The present work concerns the modification of the geopolymer at the chemical and nanostructural level, through the condensation process in **alkaline conditions** [2]. The **sol-gel synthesis** is an eco-friendly approach to functionalize geopolymers, without high temperature treatments, perfectly in accordance with the principles of circular economy and green chemistry [3]. The **alkoxysilane agents** may be chosen for the implementation of specific properties of the geopolymer materials that allow the production of various types of coatings, such as protective coating, reflective or anti-reflective coatings, refractory linings, coatings with controlled porosity.

2. Geopolymerization

Clay materials: Kaolin, Diatomite, Montmorillonite, Volcanic Ash, Blast furnace slag.
Alkaline activator: 1. NaOH 7M (28% w/w), 2. NaOH 9M (36% w/w), 3. KOH 7M (40% w/w), 4. KOH 9M (50% w/w)



3. Functionalization

There are two methods of functionalising the geopolymers used in this preliminary phase:

1) the **treatment** of the geopolymeric surface, post-drying, through the application of the sol-gel directly on the monolith, for a modification of the surface properties;


Untreated Geopolymer


Treated Geopolymer

2) the **pre-treatment** of the geopolymeric mixture, through the addition of the selected alkoxysilane, can induce a homogeneous consolidation of the molecular structure, implementing the properties of the entire monolith.


Untreated Geopolymer


Pre-treated Geopolymer

4. Characterization

The preliminary characterization of the clays by powder X-ray Diffraction (XRD) analysis (Figure 1,2), through which it was possible to identify the type of clay and its chemical composition.

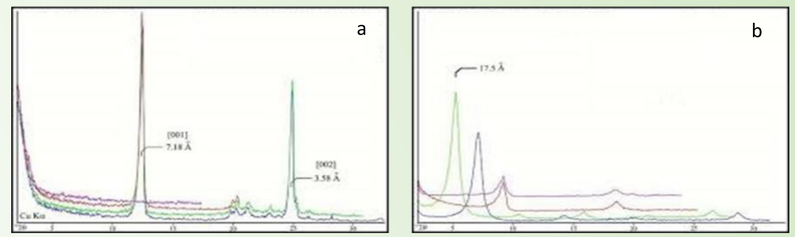


Figure 1. Powder X-ray diffraction spectra (XRD) for kaolinite (a) and Montmorillonite (b) minerals

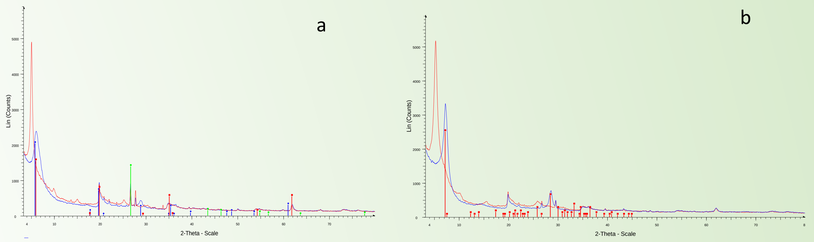


Figure 2. Powder X-ray diffraction spectra (XRD) for clays (Montmorillonite) before (a) and after (b) functionalization

5. Conclusions

- Geopolymers are considered green materials with respect to Portland cement;
- Functional hybrid sol-gel coatings are sustainable materials widely used for their hydrophobic, anti-abrasive, antibacterial and antifouling action for building sector;
- A simple procedure was tested for the production of a polymeric hybrid sol-gel starting from natural clay or waste materials, which is applied to the geopolymers both in the pre-treatment phase and after drying.

References.
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