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Composite geopolymeric materials obtained from kaolinite clays, waste residues and alkaline silicates

Luis Pérez-Villarejo¹, Dolores Eliche-Quesada¹, Sergio Martínez-Martínez¹, Eduardo Bonet-Martínez¹, Pedro J Sánchez-Soto² and Jesús Ma Rincon³¹University of Jaén, Spain²Instituto de Ciencia de Materiales de Sevilla, Spain³University Miguel Hernández, Spain

Geopolymer describes a new family of inorganic compounds investigated since 1978 as a material composed of three-dimensional aluminum silicates with semi-amorphous and/or semi-crystalline structure. Geopolymer describes a new family of inorganic compounds investigated since 1978 as a material composed of three-dimensional aluminum silicates with semi-amorphous and/or semi-crystalline structure. The geopolymer reaction is produced by a chemical etching high-alkalinity condition reactions between aluminosilicates thermally treated and for producing, thus, new chemical bonds Si-O-Al-O. The geopolymers have the similar chemical composition of zeolites, but however their structure is amorphous. They are inorganic polymers with excellent physical, chemical and mechanical properties after a curing period, such as high bending and compression strength, high surface hardness, low adsorption of water and low permeability, negligible contraction and thermal stability and chemical resistance. The condensed structure of geopolymers has cementitious properties, with advantages over conventional Portland cements that their manufacture involves none emission of large amounts of carbon dioxide to the atmosphere with saving of energy. In this work, the preparation of geopolymeric materials with Na or K starting from kaolinite and waste silicate residues and alkaline silicates has been investigated. The raw materials and the geopolymeric materials have been characterized by: XRF, XRD, FTIR and the microstructure under SEM-EDS. A previous chemical and mineralogical characterization has allowed to find different elements of Si and Al and the content of aluminosilicates and secondary minerals. The raw samples were ground and the powders were treated at 750°C for 1 hour and subjected to a thermal activation. The resultant powders have been used as raw materials to obtain the geopolymer composites with Na or K by chemical treatment using distinct formulations of alkaline silicates with NaOH or KOH and variable Si/ K molar ratios. The mixed solids and liquids have been thermally treated at 70°C for 24 hours. After that, it has been demonstrated the formation of geopolymer materials by hydroxylation and polycondensation characterized with distinct Si/ Al molar ratios according to the raw materials. All these new geopolymers were amorphous depicting IR characteristics bands. The structural examination by SEM-EDS revealed the presence of microcracks and pores in the resultant materials when sodium silicate/ NaOH is used, which have been associated to the thermal and chemical treatments. When potassium silicate/ KOH is used as chemical basic reagent for metakaolinite dissolution, it has been observed the formation of nanoprecipitates (size range = 1-5 nm). From the molar ratio Si/ Al, it is deduced that the geopolymer materials are of the type sialate-siloxo, as well as the high purity of this material when purer raw samples are used in the synthesis. Finally, some tests using strong acids demonstrated the chemical stability and durable properties of these final composite geopolymers.

sergiomartmart@gmail.com
smartine@ujaen.es

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