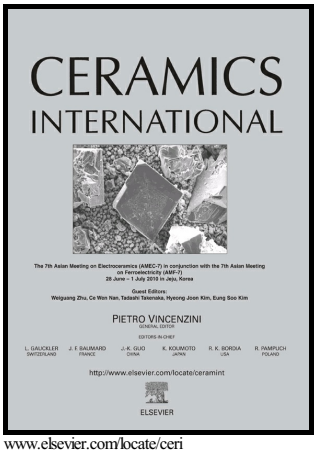

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Characterisation and Properties of Geopolymer Composite Part 1: Role of Mullite Reinforcement

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Abstract

Geopolymer-mullite composite was prepared using fly ash and mullite powders with sodium silicate and sodium hydroxide as alkaline activators. Mullite was used as a replacement to fly ash in the 20-60 wt% range. Sodium silicate to sodium hydroxide (12M) ratio was 1:1 while the liquid to solid ratio was 0.6:1. X-ray diffraction (XRD) analysis revealed that the set of geopolymer specimens without mullite replacement (control) showed the co-existence of amorphous and crystalline phases of quartz, magnesioferrite (Fe_2MgO_4), Lazurite ($Na_{8.56}(Al_6Si_6O_{24})(SO_4)_{1.56}S_{0.44}$) and calcium silicate hydrate. With an increasing amount of mullite replacement, calcium silicate hydrate and magnesioferrite diminished while the new phase of phillipsite $(K, Na)_2(Si,Al)_8O_{16}\cdot 4H_2O$) emerged. Microstructural analysis revealed Si-rich mullite needles possibly occurred by recrystallization of the original mullite. This suggestion was also confirmed by the change of the crystallite size as analysed using an X-ray diffraction technique. The ambient compressive strength was found to increase from 58±21 MPa for the control geopolymer to 72-76 MPa, with a much smaller uncertainty, for the geopolymer-mullite composite. Modulus of rupture (MOR) was found to improve significantly from 0.7±0.3 MPa to 3.7±0.5 MPa in the 20 % replacement and further to 7.8±1.3 and 8.1±1.1 MPa in the 40 and 60% replacement respectively. Improvement of fire resistance was observed in the 40-60% replacement thermal shock resistance property, however, was unchanged in these geopolymer-mullite composite.