ABSTRACT - POSTER

Influence of mixing and curing conditions on the properties of metakaolin – potassium silicate geopolymer

Franklin CASARRUBIOS[1], Flavie GENDRE[1], Camille ZOUDE[2], Alexandre MEGRET[1], Maurice GONON[1]

1 Materials Institute, University of Mons (UMONS), Mons, Belgium

2 Belgian Ceramic Research Centre (BCRC), Mons, Belgium

Abstract

Advanced ceramics exhibit outstanding properties but require high-purity powders and sintering technologies with high energy consumption. Silicate ceramics offer lower properties but can be an advantageous alternative to advanced ceramics for many applications. For example, cordierite ($2MgO\ 2Al_2O_3\ 5SiO_2$) shows a low coefficient of thermal expansion ($2 – 3\ 10^{-6}$/K) and good mechanical properties that makes it widely used as a substrate for catalytic converters within the automotive industry. The large production of catalytic converters leads to significant volumes of end-of-life waste. Studies are carried out on the recovery of precious metals, but also on the substrate itself [1]. However, cordierite cannot be reintroduced into the primary production process, which relies on the reactive sintering of kaolin, talc, and alumina. On the opposite, the thermal consolidation of green parts made from recycled cordierite is based on solid-state sintering requiring high temperatures and a fine particle size distribution to enhance the diffusion mechanisms.

The ECOMAT-UMONS project aims to develop a low-energy and low greenhouse gas emission route. The project explores the possibility of a consolidation of recycled cordierite below 100 °C by using a geopolymer binder. The cordierite–geopolymer composite, potentially shaped by additive manufacturing, is intended for applications in catalysis and filtration, withstanding temperatures of up to 1000 °C [2].

As part of this project, it is essential to optimize the process related to the preparation of the geopolymer. This study focuses on the influence of mixing (speed – time) and curing (temperature – time) conditions on the properties of a metakaolin – potassium silicate geopolymer. Density/porosity and Young's modulus are characterized after curing and heat treatment at 1000 °C, simulating the first use in temperature. Concerning the mixing, SEM analysis reveals the presence of metakaolin which did not react during the geopolymerization reaction, when the mixing condition was too low. This leads to a decrease in the mechanical properties. Furthermore, while the curing temperature is 80 °C, the samples tend to buckle during the heat treatment at 1000 °C. This buckling is worsened with the increase in the curing time.

Keywords: Geopolymer, High-temperature, Mixing, Curing

Reference:

(1) Trinh, H. B.; Lee, J.; Suh, Y.; Lee, J. A Review on the Recycling Processes of Spent Auto-Catalysts: Towards the Development of Sustainable Metallurgy. *Waste Management* **2020**, *114*, 148–165. https://doi.org/10.1016/j.wasman.2020.06.030.

(2) Casarrubios, F.; Marlier, A.; Lang, C.; Abdelouhab, S.; Mastroianni, I.; Bister, G.; Gonon, M.-F. Characterization of the Evolution with Temperature of the Structure and Properties of Geopolymer-Cordierite Composites. *Ceramics* **2024**, *7* (4), 1513–1532. https://doi.org/10.3390/ceramics7040098.