

ABSTRACT - POSTER

Drying Optimization and Porosity Development in Cordierite-Geopolymer Composites from Recycled Waste for high-temperature applications

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Achieving carbon neutrality in the ceramic industry by 2050, as targeted by the European Union, requires the development of sustainable alternatives to virgin raw materials and energy-intensive manufacturing processes. In this context, increased waste valorization and circular economy strategies offer promising solutions for reducing both resource consumption and greenhouse gas emissions.

The ECOMAT-UMONS project focuses on the recycling of cordierite waste ($\text{Mg}_2\text{Al}_4\text{Si}_5\text{O}_{18}$) generated during the production of automotive catalytic converters. Due to the reactive sintering involved in conventional cordierite manufacturing, this recycled material cannot be reintroduced into the primary production process, producing large amounts of unusable cordierite waste. Furthermore, sintering of cordierite alone provides insufficient consolidation. To address these limitations, the present work investigates the use of a geopolymer binder to achieve cold consolidation of recycled cordierite.

The targeted application is the production of porous materials (30-40 vol%) capable of operating at temperatures up to 1000 °C for liquid and gaseous effluents treatment. The composites are manufactured by casting, facilitating industrial implementation, while the feasibility of producing complex structures with hierarchical porosity by Direct Ink Writing is also explored. Finally, the first high-temperature service cycle will provide the final thermomechanical properties of the parts.

Composites containing 55 wt.% recycled cordierite and geopolymer binders with K/Al ratios of 1.0, 1.5, and 2.0 were produced. Porosity evolution was characterized in both dried and heat-treated (1000 °C) samples using nitrogen physisorption (BET), mercury intrusion porosimetry, helium pycnometry, and scanning electron microscopy. Particular attention was paid to the drying stage, as inadequate drying can alter the pore structure and compromise sample integrity. Thermogravimetric analysis and controlled oven-drying experiments were therefore conducted to optimize drying conditions, including temperature and heating rate. In addition, crystallinity, Young's modulus, and total porosity were evaluated to assess the influence of processing parameters on the material properties.

Keywords: Geopolymer, Cordierite, Porous materials, Drying, High temperature Applications