DEVELOPMENT OF GEOPOLYMER MATERIALS FOR SUSTAINABLE DESIGN

Laura Ricciotti, Department of Architecture and Industrial Design, University of Campania, Italy
laura.ricciotti@unicampania.it
Alessio Occhicone, Department of Engineering, University of Naples 'Parthenope', Centro DirezionaleItaly
Claudio Ferone, Department of Engineering, University of Naples 'Parthenope', Centro Direzionale, Italy
Raffaele Cioffi, Department of Engineering, University of Naples 'Parthenope', Italy
Giuseppina Roviello, Department of Engineering, University of Naples 'Parthenope', Italy

Key Words: Geopolymer; Sustainability; Life Cycle Assessment; composites; 3D-Printing.

The recent introduction of the Next Generation EU packages on the circular economy and the Italian Ecological Transition Plan has further boosted the research of effective routes to design materials with low energy and low environmental impact, in all areas of research, including art and design and cultural heritage. In this framework, we present the preparation and characterisation of geopolymer-based materials by valorising industrial wastes and by-products (such as porcelain stoneware wastes and so on). The good physical, mechanical, and morphological characteristics, along with the excellent adhesion of these materials to common substrates such as pottery and earthenware, suggest their use in the field of sustainable buildings and, technical-artistic value-added applications, such as restoration, conservation, and/or rehabilitation of historic monuments, or for building revetments [1]. A comparative "cradle to grave" Life Cycle Analysis between the production processes of ceramic stoneware products and geopolymeric materials based on ceramic wastes confirmed the effectiveness of the Eco-design approach that represents a strong contribution to the environmental and economic sustainability of the Italian ceramic industry [2].

In order to develop such materials using 3D printing technology, which is considered to have a lower environmental impact than traditional production processes, we used our experience in the preparation of geopolymer composite materials to develop geopolymer-based composites with polyvinyl acetate (PVAc), a polymer considered more environmentally adapt than the analogous inorganic or polymeric materials (compatible and soluble in organic solvents) currently used in the restoration and revetment sectors. [3]. These systems were synthesized by using a co-reticulation reaction that occurs between the organic phase and the geopolymer. It has been reported that the presence of the organic phase generates a change in the viscosity of the slurry, resulting in a mixture characterized by a good thixotropicity while preserving good workability, which is useful to mold into different geometries and apply to vertical surfaces [3]. The possibility of modulating the viscosity of geopolymer materials to improve their printability will enable the development of formulations suitable for 3D printing.

Future developments will be addressed to chemo-rheological and chemo-kinetic studies for the realisation of geopolymer materials for sustainable design through 3D printing.

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