AMORPHOUS, SELF-HEALED, GEOPOLYMERS (ASH-G AND CERAMICS (ASH-C) MADE BY THE GEOPOLYMER PROCESSING ROUTE

Abdul W. Bhuiya, Department of Materials Science and Engineering, University of Illinois at Urbana-Champaign, USA
kriven@illinois.edu
Daniel Ribero, Department of Materials Science and Engineering, University of Illinois at Urbana-Champaign, USA
Michael Hu, Department of Materials Science and Engineering, University of Illinois at Urbana-Champaign, USA
Patrick F. Keane, Department of Materials Science and Engineering, University of Illinois at Urbana-Champaign, USA
Waltraud M. Kriven, Department of Materials Science and Engineering, University of Illinois at Urbana-Champaign, USA

This work describes the cross fertilization of conventional whiteware production by a low energy, geopolymer processing method. Bone china is conventionally made using natural cow bone ash (calcined) of hydroxyapatite (HA). In this study HA and dicalcium phosphate (DCP) particulate reinforcements were investigated in potassium-based geopolymer composites (KGP). Particulate reinforcements of 5, 10 and 15 wt % each of hydroxyapatite and dicalcium phosphate particulate were added to potassium geopolymer to compare with composites made from BASF® Metamax metakaolin (KGP MT), Mymensingh clay metakaolin, KGP(MW) and synthetic Mymensingh clay metakaolin, KGP(MW-SYN). Microstructural properties using SEM, XRD and mechanical properties using Instron were investigated for the geopolymer samples at both room and high temperature. The XRD of pure and reinforced geopolymer samples at RT confirmed the formation of geopolymer analogues with the characteristic X-ray amorphous hump at 28^0 in 2θ, along with the crystalline peaks observed in KGP (MW), as well as in potassium geopolymer reinforced with hydroxyapatite and dicalcium phosphate. Thermally treated geopolymer composites at 1150^0C/1h exhibited crystalline peaks of leucite, kalsilite, monetite and quartz confirming the signature of geopolymer ceramics at elevated temperature. SEM revealed fully reacted and homogenous aluminosilicate matrix in all the geopolymer samples cured at room temperature for 7 days. Geopolymer composites KGP (MT)-15 DCP, KGP(MW)-15DCP and KGP(MW-SYN)-15DCP after thermal exposure at 1150^0C revealed microstructural integrity with the formation of phosphate glass, while a self-glazed surface was developed in KGP (MW) after being heated at 1125 ^{0}C/1h. Their high temperature properties are superior to RT properties due to amorphous self-healed glass formation (ASH) from the DCP phosphate glass. Their high temperature properties were superior to RT properties due to amorphous self-healed glass formation (ASH) from the DCP phosphate glass. The optimum DCP content was 10 wt % which gave flexure strengths of ~32 MPa after heat treatment at 1150 °C/1h.