

Development and Characterization of Basalt-Based Glass-Ceramic Composites for Extreme Environment

Aleksa Luković¹, Diana Carolina Lago², Jozef Kraxner², Branko Matović¹, Dušan Galusek², Bratislav Todorović³, Sanja Petrović³, Jelena Maletaškića¹

¹ Vinča Institute of Nuclear Sciences - National Institute of The Republic of Serbia, University of Belgrade, Mike Petrovića Alasa 12-14, Belgrade 11000, Serbia

² FunGlass, Alexander Dubček University of Trenčín, Študentská 2, 911 50, Trenčín, Slovakia

³ Faculty of Technology, University of Niš, P.O. Box 79, 16000 Leskovac, Serbia

https://doi.org/10.65614/uisk_yucorr.2025.26.ch34

Abstract

This study presents the synthesis and characterization of durable basalt-based glass-ceramic materials and composites tailored for chemically and mechanically aggressive conditions. Utilizing basalt rock from the Vrelo deposit in Serbia as the primary precursor and iron mine tailings from the Bor mining region as a sustainable additive, glass-ceramics were produced via high-temperature melting, quenching, and controlled thermal treatment. Comprehensive analyses, including DTA, XRD, HT-XRD, FTIR, and SEM/EDS, confirmed the formation of fine-grained pyroxene-type silicates, predominantly diopside and augite, with no compromise in microstructural integrity due to tailings incorporation. Chemical durability was assessed through immersion tests in aqueous solutions at pH 3, 7, and 12 for up to 30 hours. ICP-OES analysis revealed minimal elemental leaching, and SEM/EDS verified no surface degradation or compositional changes post-corrosion, underscoring exceptional chemical resistance. These findings highlight the potential of basalt-based glass-ceramics, enhanced by industrial waste, for applications in geotechnical barriers, chemical reactor linings, and waste containment systems, offering a sustainable and high-performance solution for demanding industrial and environmental challenges.

Keywords: Basalt glass-ceramics; chemical durability; sustainable materials; mine tailings; extreme environments