

Ozone-Loaded Bacterial Cellulose Hydrogel: A Sustainable Antimicrobial Solution for Stone Cleaning

The application of biocide-loaded hydrogels has recently been utilized for cleaning biological attacks on cultural heritage and architectural stone materials. However, due to the drawbacks of traditional biocides and the high costs associated with synthetic polymers, there is increasing research focused on finding innovative and sustainable solutions. This work aims to investigate a bacterial cellulose (BC) hydrogel functionalized with ozone as a renewable, biodegradable, and eco-friendly antimicrobial treatment for stone biodeterioration. The ozonated BC (OBC) hydrogels were tested against selected biodeteriogenic microorganisms in water suspension, effectively eliminating their viability, with complete suppression observed after 10 minutes and 24 hours of treatment with OBC for bacterial and fungal spores, respectively. Additionally, OBC was evaluated on contaminated specimens of marble, brick, and biocalcarenic stone to simulate in situ conditions. A 100% reduction in microbial viability was achieved after a 24-hour treatment. The hydrogel's shelf-life and antimicrobial activity were also assessed after 30 days, demonstrating sustained cleaning efficiency over time. This research underscores the potential of the new ozonated BC hydrogel as a green and highly effective antimicrobial treatment with significant sustainability benefits.