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Sintered and 3D-Printed Bulks of MgB_2-Based Materials with Antimicrobial Properties

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Abstract: Pristine high-density bulk disks of MgB_2 with added hexagonal BN (10 wt.%) were prepared using spark plasma sintering. The BN-added samples are machinable by chipping them into desired geometries. Complex shapes of different sizes can also be obtained by the 3D printing of polylactic acid filaments embedded with MgB_2 powder particles (10 wt.%). Our present work aims to assess antimicrobial activity quantified as viable cells (CFU/mL) vs. time of sintered and 3D-printed materials. In vitro antimicrobial tests were performed against the bacterial strains *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Staphylococcus aureus* ATCC 25923, *Enterococcus faecium* DSM 13590, and *Enterococcus faecalis* ATCC 29212; and the yeast strain *Candida parapsilosis* ATCC 22019. The antimicrobial effects were found to depend on the tested samples and microbes, with *E. faecium* being the most resistant and *E. coli* the most susceptible.

Keywords: MgB_2; antimicrobial activity; spark plasma sintering; machinable material; 3D printing

1. Introduction

Planktonic and biofilm-forming microbes are among the most important threats to human health. In the EU, 25,000 people die every year due to infections with antibiotic-resistant bacteria, and the management of these infections costs about 1.5 billion EUR/year [1]. This problem could be considered a crisis, because the rate of development and commercialization of novel effective antibiotics has slowed [2]. Moreover, government funds and efforts have recently been focused on other urgent problems, such as the COVID-19 pandemic crisis. From 1930 to 1962, 20 new types of antibiotics were developed; meanwhile, from 1962 to the present, only 2 new types of antibiotics have gone into production [3–5]. Modern antimicrobial strategies are needed [6], and among them, nanostructured materials such as powders, coatings, and bulks are promising candidates [7–9]. The literature also offers examples of many bioactive metals including Ag, Cu, Zn, Mg, Ce, Ti, Al, Si, Au, Bi, Ca, Fe, Pt, Sn, Hg, Cd, Cr, Tl, Al, Co, In, Ni, Mn, and Cr [10–14]. The first two, Ag and Cu [15], are the most popular, being already used in many antimicrobial applications. Metals are often used as oxides, hydroxides, halides, and sulfates [10,16] or they are introduced as active components in alloys (e.g., brasses, bronzes, copper–nickel–zinc) and in composite