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ORIGINAL PAPER

Optimization modelling of spark plasma sintering parameters of SS316-B_4C composite

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Abstract
Process parameter optimisation is often performed to improve process efficiency and cost-effectiveness. To fabricate stainless steel (SS316)-10 wt% boron carbide (B_4C) composite, spark plasma sintering is being researched for the process parameter optimisation of temperature, pressure, dwell time, and heating rate. The sintering operation was carried out utilising the grey relational analysis and an analysis of variance to determine the impacts of the response variables microhardness and density. The spark plasma sintering technique is used to solidify the composite powders under a wide range of conditions, including temperatures of 800 °C, 900 °C, and 1000 °C; pressures of 60 MPa, 70 MPa, and 80 MPa; dwell times of 5 min, 10 min, and 15 min; and heating rates of 100 °C/min, 200 °C/min, and 300 °C/min. Scanning electron microscopy, Micro Vickers hardness testing, and Archimedes-based density testing are being used to examine the microstructure, hardness, and density of sintered compacts. The findings revealed that the sintering temperature and pressure had a significant influence on the compacts' properties. The ideal circumstances for spark plasma sintering parameters in this research include 900 °C temperature, 70 MPa pressure, 10 min of dwell time, and a heat rate of 200 °C/min, resulting in a high density of 7.35 g/cm^3 and an optimum level of microhardness of 1450 HV.

Keywords Optimisation · Spark plasma sintering · Stainless steel 316 · Boron carbide

1 Introduction

Compared to other notable varieties of stainless steel (SS), SS316 stands out for its superior corrosion resistance and ductility. Stainless steel is used in a variety of manufacturing sectors due to its excellent properties [1–3]. Boron carbide (B_4C) particles are among the most promising ceramic reinforcement particles because of the physical and mechanical characteristics that make them effective for factors like armour plates that are lightweight for their ballistic capabilities and wear-resistant materials for their tribological properties. Nuclear reactors utilize boron carbide to act as neutron shielding [4–6].

ANOVA was used to analyse the coated substrate with g-C3N4/MoS_2 nanocomposite to minimise wear loss. These factors show how their interactions have an effect. The results of the Taguchi approach and the response surface methodology conclude well with the experimental results [7, 8]. A great deal of research has shown that metal matrix composites (MMCs) can exhibit tribological and mechanical characteristics that are influenced by B_4C [9]. Spark plasma sintering (SPS), a non-traditional sintering technique, has recently received considerable interest [10, 11]. This novel method has gained enough appeal as it can completely consolidate ceramics, intermetallic, MMCs, and metal matrix nano-composites (MMNCs) at relatively low temperatures [12]. On a macroscopic level, it uses heat to sinter a powder compact rapidly. It is used at a nanoscale level to provide the powder particle's contacting point. Several applications have been demonstrated that can be achieved using SPS,

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