



## Original Research Paper

# Microstructure and abrasive behaviors of TiC-316L composites prepared by warm compaction and microwave sintering

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## ABSTRACT

316L stainless steel composites with various weight fractions of TiC particles were prepared using warm compaction and microwave sintering. Abrasion resistance measurements were used to study the abrasive behaviors of TiC-316L stainless steel composites. The effects of TiC content and preparation methods on the microstructure and mechanical properties of 316L stainless steel composites have been investigated. The results showed that the sample prepared by warm compaction and microwave sintering exhibited significantly superior densification, higher hardness, and better abrasion resistance when compared with conventionally processed counterpart. TiC particles reinforcement improved the abrasion resistance of 316L stainless steel, and the abrasion resistance of the composites was considerably better than that of the 316L stainless steel. The volume loss initially decreases with increasing TiC content up to 5 wt.%, it then slightly increases as increase the TiC particles content to 10 and 15 wt.%. In this present abrasion tests, the composites using 5 wt.% TiC addition offers a high abrasion resistance.

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## 1. Introduction

316L stainless steel is widely used in medical treatment field, food profession, and chemical industry because of its excellent corrosion and oxidation resistance and good formability. However, application of this material is hindered by its low mechanical strength and poor anti-friction properties [1–3]. In order to improve its mechanical properties, many authors have studied the effect of different approaches to strengthening stainless steel [4–6]. As one way to improve their mechanical properties, composite materials were developed using ceramic particles (e.g., Y<sub>2</sub>O<sub>3</sub>, SiC, Al<sub>2</sub>O<sub>3</sub>, TiB<sub>2</sub>, and TiC) as reinforcement. Among these hard ceramic particles, TiC particles are believed to be a suitable reinforcements for steel matrix composites due to their high hardness, low density, good wettability, and their relative stability with steel matrix [7–9].

Powder metallurgy (PM) is thought to be the most common production technique for ceramic particles reinforced composites [6,10]. One of the advantages of PM compared to other methods is having better control on the microstructure, where better distribution of the reinforcements is possible in PM compacts [11]. However, in order to achieve the best performance, conventional PM

processing of composites requires long time sintering at high temperatures, which results in an excessive grain coarsening and leads to subsequent loss of mechanical properties [12].

Compared with conventional sintering, microwave sintering presents unique advantages, which include saved energy, enhanced densification, and suppressed grain growth owing to very rapid heating rates and cycles [13,14]. Therefore, microwave sintering as preparation processing of stainless steel composites has the potential of enhanced mechanical properties. Padmavathi et al. [15] have reported that stainless steel composites can be effectively sintered using microwave. They pointed out that microwave sintering results in higher densification and a relatively refined microstructure in 316L stainless steel composites compared with conventional sintering. Panda et al. [16] analyzed the effect of conventional and microwave sintering on the properties of YAG-dispersed austenitic stainless steel. Their analysis showed that 316L stainless steel composites can be prepared by microwave sintering and have a superior mechanical and tribological response.

Though microwave sintering has been successfully applied to develop stainless steel composites, however, the compactness of green compact before sintering has a great effect on the final density and mechanical properties of sintered composites. Generally, green compact is achieved by conventional cold compaction method. Compared with cold compaction, warm compaction can obtain green compacts with higher relative density under a lower

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