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Characteristics of Aluminum and Magnesium Based Nanocomposites Processed Using Hybrid Microwave Sintering

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ABSTRACT

Powder metallurgy is one of the highly established methods to synthesize metals, alloys and composites. Sintering is one of the important steps in powder metallurgy methodology and is usually realized through conventional resistance furnaces. The sintering usually takes a few hours to realize density in excess of 90%. The present study highlights the use of energy efficient and environment friendly microwave sintering route to synthesize pure aluminum, magnesium and magnesium based nanocomposites. Three reinforcements were targeted: a) silicon carbide, a microwave susceptor, b) alumina, a microwave transparent material and c) copper, a conducting material. Composites were prepared using blend – compact - microwave sintering - extrusion methodology. Process evaluation revealed that microwave assisted sintering can lead to a reduction of 86% in sintering time and energy savings of 96% when compared to conventional sintering. Moreover, microwave assisted sintering of metal compacts in this study was carried out in air, in the absence of any protective atmosphere, without compromising the mechanical properties of the materials. Results revealed that properties of magnesium can be convincingly enhanced using the said processing methodology and the materials formulations selected. Most importantly, the study established the viability of microwave sintering approach used in place of conventional sintering for magnesium based formulations.

KEYWORDS: Microwave sintering, Magnesium, Aluminum, Nanocomposites, Mechanical properties

INTRODUCTION

Improving energy efficiency has been identified as the cheapest, fastest and most environmental friendly way to meet the increasing demand of energy by the International Energy Agency (IEA) [IEA, 2006]. This can be achieved through innovation, the adoption of new cost-effective technologies and a better use of existing energy-efficient technologies.

Microwave heating is an emerging technology that can be used for the rapid and efficient heating of a wide range of different materials [Stein, 1994; Clark and Folz, 2005]. Some of the advantages of microwave heating include reduction in processing time, volumetric and uniform heating, selective and controlled heating, improved properties, environmental friendliness and potential in the synthesis and processing of novel and/or nanostructured materials. Currently, microwave heating is mainly used for the processing of food and in selected applications such