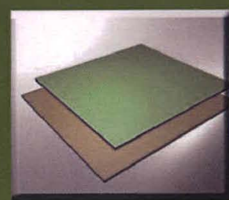
ADVANCES IN COMPOSITE MATERIALS



Iskandar Idris Yaacob
Md Abdul Maleque
Zahurin Halim

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Chapter 031

Fabrication of Nickel Aluminide Intermetallic-Alumina Nanocomposite

Roslina Ismail[1] and Iskandar I. Yaacob[2]
[1]Faculty of Engineering, University of Malaya
[2]Kulliyyah of Engineering – International Islamic University Malaysia
✉ : iskandar_yaacob@iium.edu.my

Keywords: Intermetallic; nanocomposite; powder metallurgy; saturation magnetization.

Abstract: Nickel aluminide-Alumina nanocomposite was prepared by a conventional powder metallurgy technique. Nano-size alumina as dispersed phase was mixed with Ni and Al powder in a planetary ball mill for 4 hours at 350 rpm. The mixture was then compacted using a hydraulic press at 400MPa for 15 minutes. Sintering was done under inert condition in a tube furnace at 660°C with 5 hours soaking time. The occurrence of reaction synthesis during sintering was detected by the presence of a 'large' exothermic peak of the differential thermal analysis curve, which occurred below 600°C. The hardness value for the composite containing 5% Alumina was about two times higher than Ni_3Al intermetallic. Its saturation magnetization (Ms) was very low indicating the presence of a small amount of elemental Ni. X-Ray Diffraction (XRD) measurements showed peaks corresponding to Ni-Al and Ni_3Al indicating the formation of the desired intermetallics.

Introduction

The development of intermetallic matrix composites (IMCs) has been driven primarily by the need for structural materials with better specific strength and modulus than monolithic metals or alloys, especially at high temperatures [1-2]. However the most intriguing characteristics of intermetallic matrix composites are the ability to tailor their mechanical and physical properties over much greater temperature ranges compared to monolithic materials.

Wider use of IMCs requires improvements in the synthesis and processing so that high performance parts can be produced more economically. There are several techniques for synthesizing the IMCs. These include the conventional melting and solidifications such as the highly successful Exo-melt™ process [3-4], reactive sintering of constituent powders [5-6], self propagating high temperature synthesis [7], and more recently the reactive infiltration of the low melting point constituent metal into the powder preform of the other constituents [8].

Intermetallic nickel aluminide exhibits many extraordinary properties [1, 9]. These are high melting point without transformation to solid solution as commonly observed in most nickel based superalloys and increasing yield strength with temperature due to formation of coherent gamma prime precipitates [10-11]. The intrinsically brittleness of nickel aluminide at ambient temperature can be eliminated by adding a small amount of Boron (0.1-0.4wt %) [12]. The introduction of high temperature ceramic reinforcements such as Al_2O_3, SiC, and