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Fabrication and thermal characterization of amorphous and nanocrystalline Al_9FeNi/Al_3Ti compound

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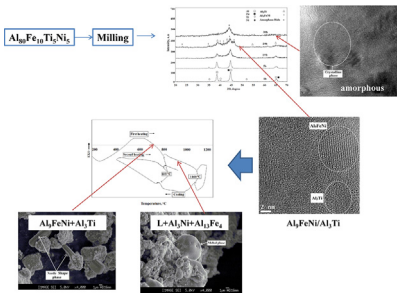
HIGHLIGHTS

- We study the effect of milling process on $Al_{80}Fe_{10}Ti_5Ni_5$ alloy.
- We study the effect of annealing on $Al_{80}Fe_{10}Ti_5Ni_5$ supersaturated solid solution phase.
- We study the effect of annealing on $Al_{80}Fe_{10}Ti_5Ni_5$ amorphous phase.
- We study the thermal behaviour of Al_9FeNi/Al_3Ti compound.

GRAPHICAL ABSTRACT



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ABSTRACT

In this study, the fabrication and structural characterization of amorphous/nanocrystalline Al_9FeNi/Al_3Ti phase has been performed. In this regards, milling and annealing processes were applied on $Al_{80}Fe_{10}Ti_5Ni_5$ (at. %) powder mixture for different periods of time. The prepared samples were characterized using X-ray diffraction (XRD), scanning and transmission electron microscopy (SEM and TEM) and differential scanning calorimetery (DSC). According to the results, supersaturated solid solution, nanocrystalline Al_9FeNi/Al_3Ti (with average crystallite size of about 7 nm) and amorphous phases indicated three different microstructures which can be formed in $Al_{80}Fe_{10}Ti_5Ni_5$ system during milling process. The formed supersaturated solid solution and amorphous phases were unstable and transformed to Al_9FeNi/Al_3Ti intermetallic compound during annealing process. It is shown that, Al_9FeNi phase in Al_9FeNi/Al_3Ti intermetallic compound can decompose into Al_3Ni, $Al_{13}Fe_4$ and liquid phases during a reversible peritectic reaction at 809 °C.

1. Introduction

Alloys and intermetallic components with aluminum content of 80–90 at. %, have attracted considerable attention due to their combination of low density, high strength and corrosion resistance. A new class of these alloys and components, which has received a great deal of attention in recent years is amorphous and nanocrystalline materials [1–4]. Indeed, this new grade of materials exhibited several superior properties that cannot be obtained in common crystalline materials [4–6]. The glass forming ability of Al-based alloys is low and there is not any report about the formation of bulk amorphous and nanocrystalline structure for this system by direct solidification methods. Nevertheless, a great number of amorphous and nanocrystalline Al-base alloys have been synthesized by various preparation methods of rapid quenching from liquid or vapor and solid-state processes [1].

The mechanical alloying (MA) process is convenient solid state

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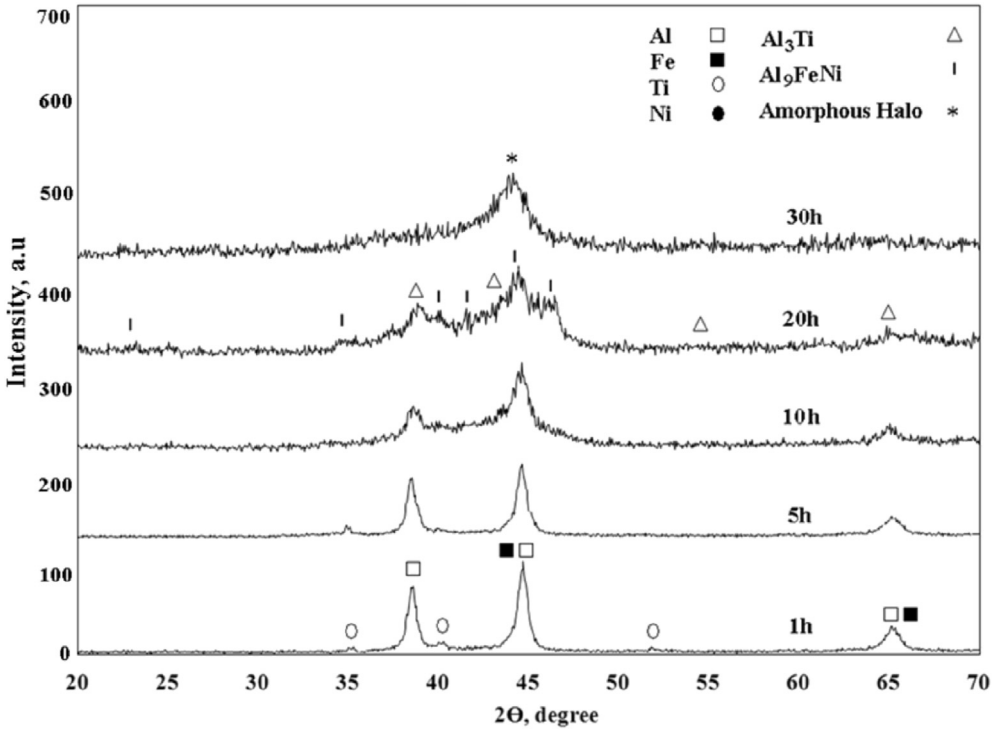

Fig. 1. XRD patterns of $Al_{80}Fe_{10}Ti_5Ni_5$ powder mixture after various milling periods.

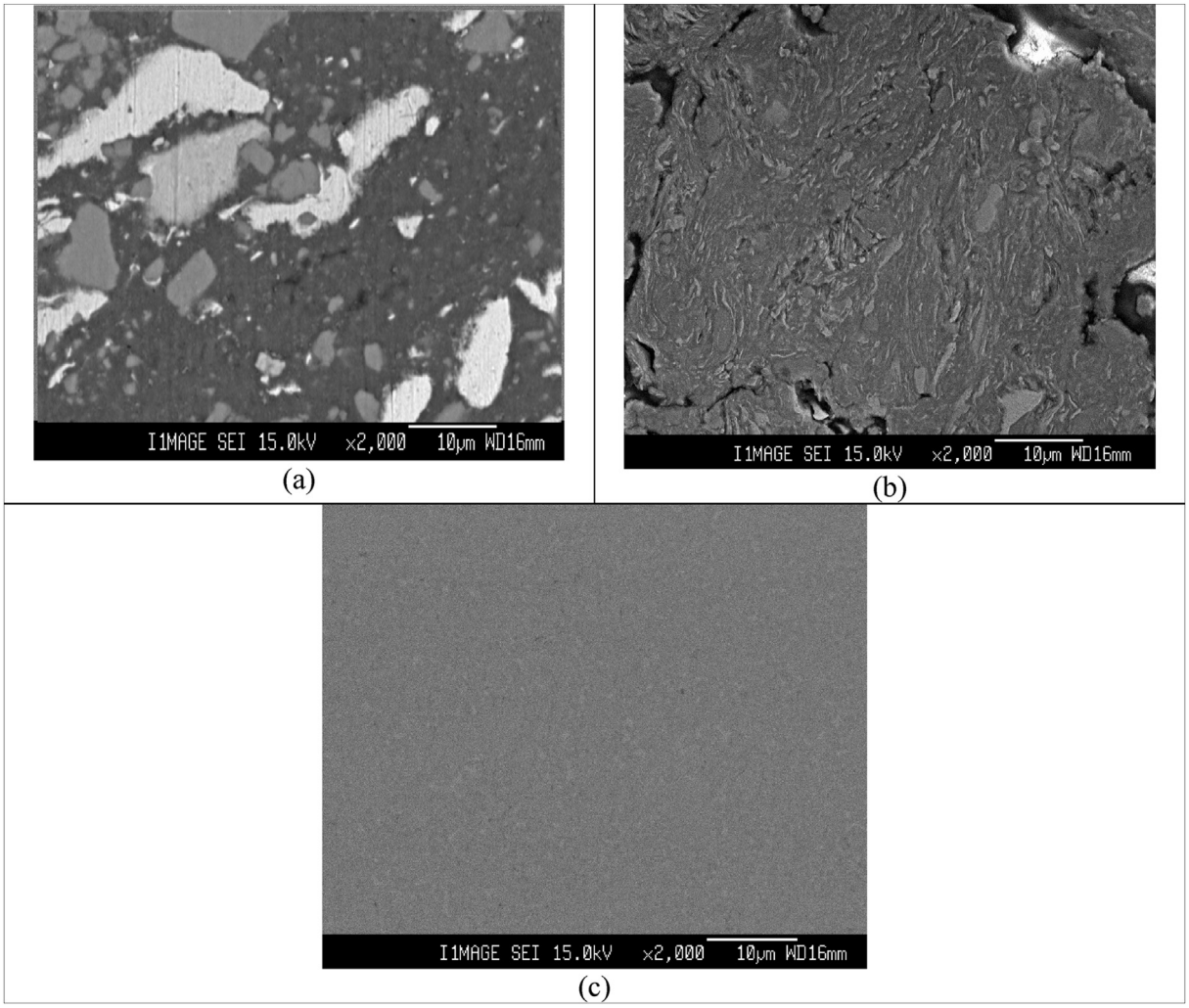

Fig. 2. Cross sectional SEM micrographs of $Al_{80}Fe_{10}Ti_5Ni_5$ powder mixture after a) 1, b) 5 and c) 10 h of milling periods.