B-7

The structural and magnetic properties of $Ni_{45}Al_{45}C_{10}$ solid solution as a function of milling times

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Abstract

We have studied the formation of alloy for $Ni_{45}Al_{45}C_{10}$ as a function of milling times. This alloy was produced using mechanical alloying. The effect of milling time on local structural changes of $Ni_{45}Al_{45}C_{10}$ has been investigated by means of EXAFS. Both XRD and EXAFS patterns from mechanically alloyed $Ni_{45}Al_{45}C_{10}$ powder indicates the formation of solid solution. The variation of lattice parameter and particle sizes could be analyzed from the different of milling times. Magnetization was also measured by using VSM.

Aims

1. NiAl alloy has a complicated phase transition as a function of their composition and alloying method;
2. So NiAl alloy consists of nanocomposite structure with alloying process;
3. We have studied the variation of microstructure with alloying process using EXAFS;
4. We also have studied the variation of local structure and magnetic properties by carbon addition.

Results

Fig. 1 shows the Fourier transformed spectrum of NiAlC alloy with alloying process measured at Ni K-edge. With increase alloying time, the intensity is reduced corresponding to the change of nearest neighbor structure, that is, Ni-Ni bonding changes to Ni-Al.

From the alloying time of 4 hrs, the atomic distance of 1st shell is significantly shifted. It means that the alloying process is really started due to the interdiffusion between Ni and Al atoms. Especially, the long range ordering is also changed above alloying time of 4 hrs. In case of NiAl alloy without Carbon, the local structural change is significantly changed.

Fig. 2 shows the magnetization variation of $Ni_{45}Al_{45}C_{10}$ alloy with milling times. The magnetization reduced with increasing milling time. The magnetization was about 0.8 emu/g. For this alloy, the magnetization decreased rapidly in the initial stage of mechanical alloying. Only slight change occurs after 4 h. With increasing milling time, welding and fracture of the powder particles occurs repeatedly. Saturation magnetic, Ms decreased with increasing the milling time because of the interdiffusion of Ni and Al increases, resulting in magnetic dilution, i.e., decrease

of the magnetization. The steady state, as shown in Fig. 2, indicate that solid solution formed. The variation of magnetization corresponds to results of XRD and EXAFS structural analysis.

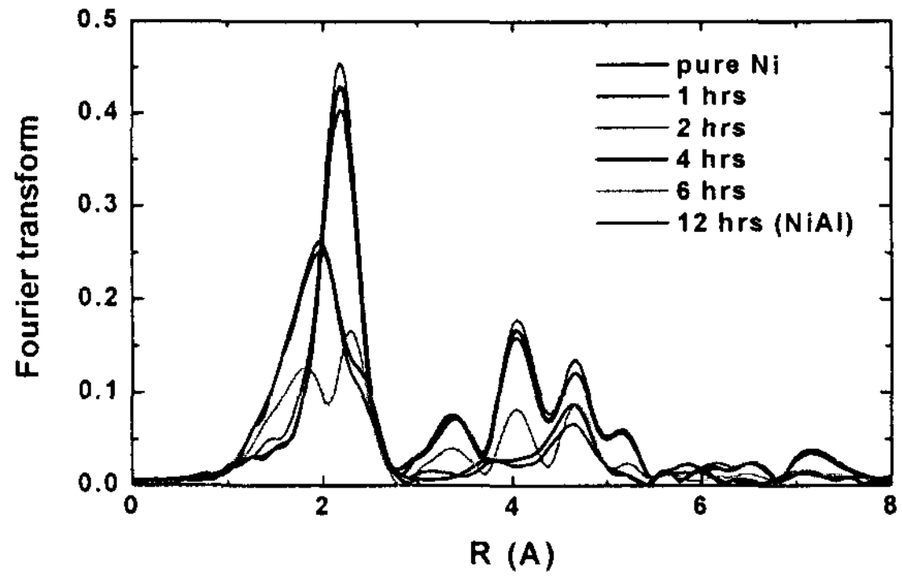

Fig. 1. Fourier transform of EXAFS spectra of mechanically alloyed $Ni_{45}Ak_{45}C_{10}$and$Ni_{50}Al_{50}$ with milling times. The vertical solid line indicates the location of Ni first shell.

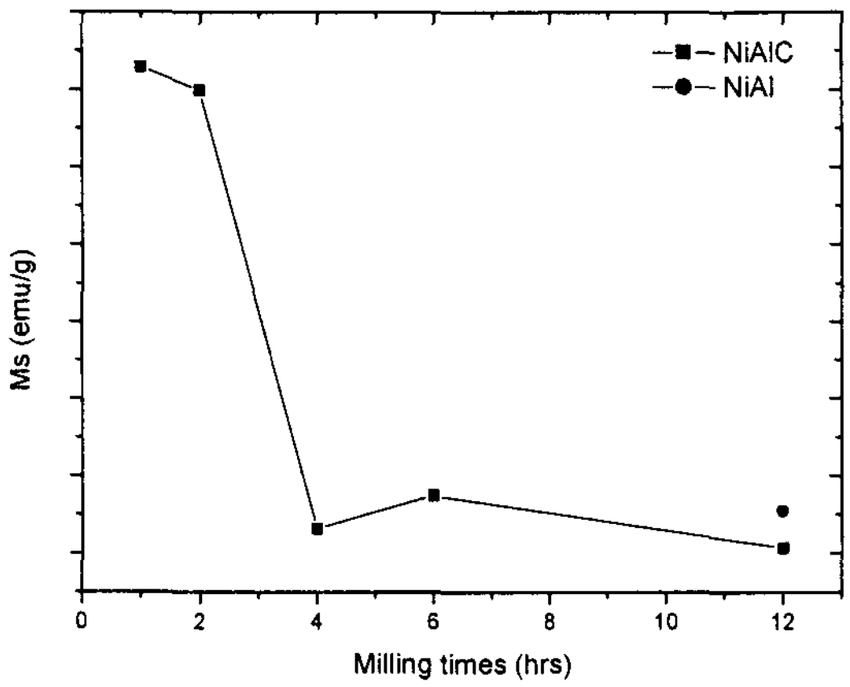

Fig. 2. Variation of magnetization of mechanically alloyed $Ni_{45}Ak_{45}C_{10}$and$Ni_{50}Al_{50}$ with milling times.