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Superconductivity of α - TiAl alloys

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The superconducting transition temperature T_c of α TiAl alloys has been measured up to 10 atomic percentage of Al. T_c monotonously increases with a tendency to saturation for high Al content.

1. INTRODUCTION

Although the theory of superconductivity is mature in explaining the basic properties as well as their material dependence of conventional superconductors, Large experimental efforts have been devoted to materials with cubic structures because of the importance for application [1]. We have made a systematic investigation of the superconductivity of hcp TiAl alloys as a function of Al content. The results could be useful in balancing the experimental data for different structures and in understanding how the theory works for materials of noncubic symmetry.

2. EXPERIMENTAL DETAILS

The TiAl samples were prepared by arc melting with Al concentration up to10 at. %. Appropriate amount of Ti (99.995% pure) and Al (99.999% pure) are melted several times. The melted ingots ere then annealed at 900 ℃ for one week to improve the structural order [2]. The procedure was proven to be very effective in diminishing the background signal and sharpening the peaks of the X-ray diffraction patterns. The analysis also showed that introducing Al to 10 at. % did not frustrate the structural order of the alloys (FIG.1).

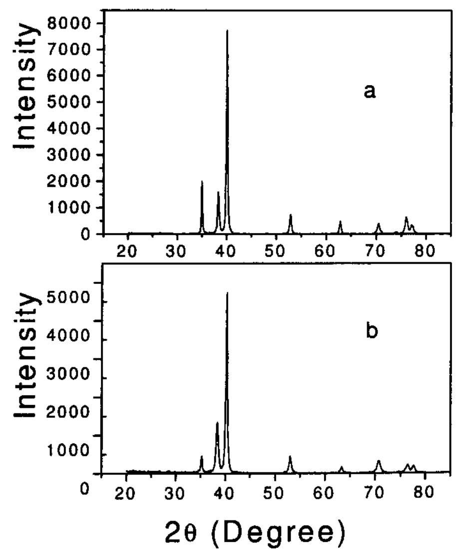

FIG.1 X-ray diffraction patterns of pure Ti (a) and Ti with 10 at. % Al (b). The patterns show that no preferential orientation exists in these two samples.

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Tc of the alloys was measured by the sample resistance. The temperature was determined by a thermometer placed close to the samples. The samples and the thermometer were all immersed in the ^3He - ^4He liquid mixture in an Oxford dilution refrigerator (Model 200 TLM).

3. RESULTS

FIG.2 presents how Al doping changes the transition temperature T_c with a tendency to saturation for higher Al concentration.

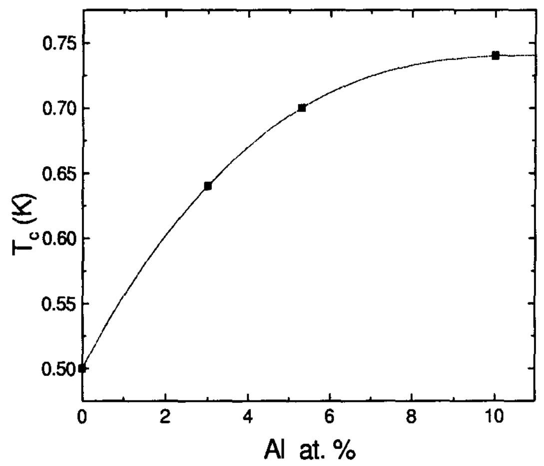

FIG. 2 .Tc change with Al content for the hcp TiAl alloys.

Since Al is a simple metal, its introduction can hardly influence the band structure of the host transition metal around the Fermi level. As we mentioned above, the FWHM of the X-ray diffraction peaks show no detectable changes by introducing 10 at. % Al. The lattice parameters decrease by less than 0.6 % for the highest Al content. Therefore, we conclude that the T_c change is caused by the Al-induced shift of the Fermi level which may result in both the changes of DOS N (E_F) and the electron-phonon coupling of the matter. The detailed discussion together with the results of H_{c2}, Hall effect, Debye temperature, and specific heat will be published elsewhere [3]

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