MAGNETIC PROPERTIES OF Fe-Mn-Al ALLOY SYSTEM
IN THE FCC DISORDERED PHASE

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In this work we report the experimental studies of Fe-Mn-Al alloys in the FCC disordered phase at room temperature by Mössbauer spectroscopy and X-ray diffraction. In this phase the alloys are antiferromagnetic with a constant mean hyperfine field ($\bar{H}$) near 26 kOe in the composition range from 0 to 7.5 at.% Al and 50 to 65 at.% Fe. When the Al or Fe concentration increases, the $\bar{H}$ value gradually decreases to zero and the alloy becomes paramagnetic. In the same way when the Al concentration increases the lattice parameter increases linearly but when the Fe concentration increases the lattice parameter remains nearly constant for alloys with 5 at.% Al and decreases for alloys with 10 at.% Al.

1. Introduction

The Fe-Mn-Al alloys system in the FCC disordered phase has been studied very little. Chakrabarti [1] showed the structural phase diagram, obtained by X-ray diffraction, of this ternary system for alloys quenched from 1000 °C. This phase diagram shows that the austenitic phase (FCC) is stable for low Al concentrations and less than 60 at.% Mn as is shown in fig. 1. The other work reported [2] is a preliminary report about its magnetic properties in which it was shown that the system is antiferromagnetic and that this magnetic behaviour is diluted with Fe or Al concentration. Several investigations of the magnetic properties of the Fe-Mn alloy system in the FCC disordered phase has been conducted. Some of them [3–6] resume the main properties of the system. These studies have shown that the alloy system Fe$_x$Mn$_{1-x}$ is antiferromagnetic and that this antiferromagnetism can be classified into three distinct groups according to the composition. For $0 \leq x \leq 0.3$ the spin structure is colinear and the Néel temperature and the magnetic moment of the alloys decrease gradually with increasing Fe concentration. For $0.4 < x < 0.8$ the spin structure is non colinear and the Néel temperature increases up to 500 K for $x = 0.5$ and then decreases to 300 K for $x = 0.8$, but the magnetic moment changes in the opposite way because it becomes minimum at $x = 0.5$ for which the moment is 1
Fig. 1. Isothermal section at 1000 °C of the Fe-Mn-Al system, showing the FCC phase and the alloys studied (●).

The magnetic hyperfine field (HF) at 0 K is nearly constant with a value of about 40 kOe. For 0.8 ≤ p ≤ 1 the spin structure is collinear and both the magnetic moment and the Néel temperature decrease with increasing p. For this range the field does not appear at room temperature (RT) because the Néel temperature is above RT. The experimental results for the second region suggest that the magnetic moment of Fe atoms is localized.

This paper mainly describes the experimental results of the Fe-Mn-Al system in the FCC disordered phase, obtained by Mössbauer spectroscopy and X-rays diffraction. The effect of the alloying elements on the antiferromagnetic character of the system is investigated.

2. Experimental procedure

The alloys were melted in an arc furnace under an argon atmosphere using Fe, Mn and Al with more than 99.9% purity. After this, they were sealed in a quartz tube in order to be homogenized by annealing at 1000 °C during five days. Then, they were quenched in iced water. Finally powdered samples were prepared for Mössbauer effect and X-ray diffraction measurements.