

## MAGNETIC, THERMAL EXPANSION, AND ELECTRICAL RESISTIVITY STUDIES OF FeAlMnC STEELS

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**Abstract.** - Several FeAlMnC alloy samples (Mn: 27.6-29.8 wt%, Al: 7.4-9.2 wt%, C: 0.6-1.3 wt%, Fe:Bal.) have been made for magnetic ( $\sigma$ ), thermal expansion ( $\Delta l/l$ ), and electrical resistivity ( $\rho$ ) studies between 10 and 300 K. Carbon and aluminum contents are found to be important in affecting those measured quantities. Temperature dependences of  $\sigma$ ,  $\Delta l/l$ , and  $\rho$  are discussed briefly.

### 1. Introduction

FeAlMnC steels are subjects of growing interests, because of their potential uses. In this paper, we made various measurements such as magnetic, thermal expansion, and electrical resistivity on several FeAlMnC steels at low temperatures ( $10 \text{ K} \leq T \leq 300 \text{ K}$ ). Because of complications of this alloy system, our report does not tend to be exhaustive and quantitative, but rather tends to be qualitative and forms complements to our previous report [1].

It was reported that by adding suitable amounts of carbon (1 wt%) or aluminum (7 wt%) [2, 3], one may stabilize the austenetic phase in FeAlMnC steels. Otherwise, the ferrite phase grows substantially in the original matrix. Also, by thermal aging these steels above 700 K, Fe<sub>3</sub>AlC or FeAlC may precipitates among various phases [4]. All these structural changes may effectively alter the magnetic, thermal expansion, and electrical resistivity properties of the steels [5-7].

### 2. Experiments

All the samples (# 1-# 5, Tab. I) used in the experiments are the same as before [1]. Their thermal treatments have been reported elsewhere [1]. For magnetic and electrical resistivity measurements, we have used the same apparatus working at low temperatures [1]. As to thermal expansion measurements, a Perkin-Elmer TMS-2 system was employed. The dilatometer was calibrated with a pure silver block.

Table I. - Concentrations, magnetic moment, and electrical resistivity of # 1 - # 5 FeAlMnC steels.

Sample	Fe	Mn	Al	C	$\sigma$ (300 K, 6 kG)		$\rho$ (10 K) / $\rho_{300}$
					(emu/g)	(emu/g)	
1	Bal	27.6	7.4	0.59	73.8(n) <sup>+</sup>	90.2(n)	— (d) <sup>+</sup>
2	Bal	29.8	7.6	0.94	0.25(l) <sup>+</sup>	— (l)	1.16(s) <sup>+</sup>
3	Bal	29.7	8.7	1.04	1.2 (l)	— (l)	1.08(s)
4	Bal	29.6	8.4	1.31	17.6(n)	8.4(l)	1.03(d)
5	Bal	29.4	9.2	0.95	14.2(n)	2.6(l)	1.04(s)

<sup>+</sup> (n): non-linear, (l): linear.

+ (d): double-minimum, (s): single-minimum.

### 3. Results and discussions

Figure 1 shows the temperature dependence of the magnetic properties of the five steels. Table I also illustrates magnitudes of the magnetic moments  $\sigma$  measured at 20 K and 300 K, and the linear or the non-linear property of  $\sigma$  ( $T, H$ ). Magnetically speaking, # 2 and # 3 steels behave similarly, and form a group. Their  $1/\chi$  versus  $T$  plots show that at  $T = 254 \text{ K}$  for # 2 steel and at  $T = 269 \text{ K}$  for # 3 steel respectively, there exist paramagnetic to antiferromagnetic transitions. For # 1 steel, its magnetic properties behave distinctly in that its saturation moment is the highest, and remains ferromagnetic from room temperature to

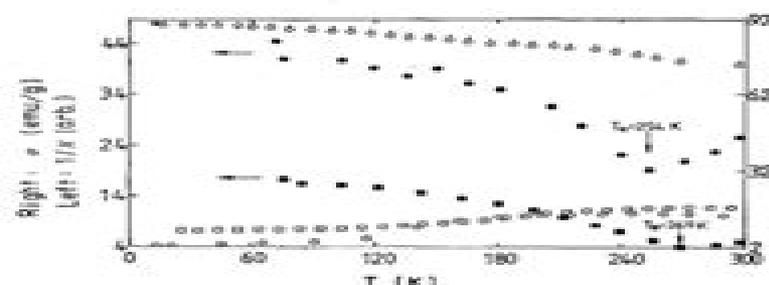


Fig. 1. - Magnetic moments  $\sigma$  at 6 kG of # 1 (o), # 4 (□) and # 5 (△) steels, and inverse susceptibility  $1/\chi$  of # 2 (●) and # 3 (■) steels as a function of temperature.

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