drift speeds are shown in Fig. 1. The drift speeds by the barium release experiment on two evening flights were around 90–100 m/s towards west and this is shown by the big filled circle in the figure with arrow in time axis showing the launch time. Similarly the drift speed in the morning flight was about 80 m/s towards east and this is again denoted by big filled circle. It is clear that the E–W drift speeds determined by the two different techniques match very well within the limits of experimental errors.

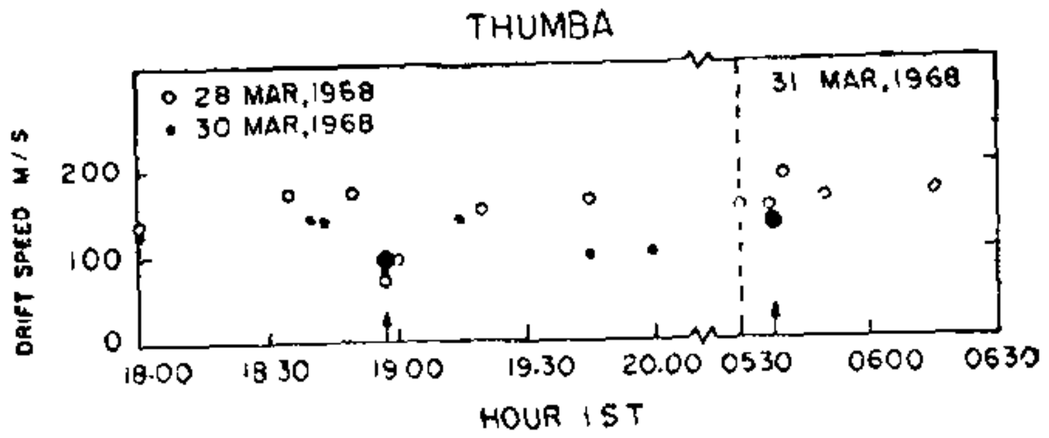

FIG. 1. F-region drift speed by spaced receiver experiment compared with the drift speed by barium release experiment, both experiments conducted at Thumba.

Drift measurements by spaced receiver technique have been compared with various other independent months in the last decade following the doubts expressed on the interpretation of spaced receiver experiments. These include winds by meteor radar in D-region[8,9] and in E-region[10–12], winds by rockets in E-region by falling sphere method[13] and in E-region by lithium trail method[14], drift in F-region by incoherent scatter method[15], in E-region at electrojet latitudes by VHF backscatter doppler shift method[16], winds in troposphere by radiosonde[17] and with space craft measurements of solar wind (being compared with spaced IPS method)[18]. All these comparisons have established spaced receiver technique as a simple and potential radio remote probing method of studying dynamics in turbulent media (neutral as well as ionized).

Sincere thanks are due to Prof. K. R. Ramanathan and late Prof. V. A. Sarabhai for encouragement and facilities towards establishing ionospheric drift station at Thumba, to Prof. R. G. Rastogi for his guidance and supervision of the activities of the ionospheric drift group at PRL and to Dr. R. K. Misra for help in making these drift observations.

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DEVIATIONS FROM KOHLER'S RULE IN FERROMAGNETIC IRON

Introduction

THE study of magnetoresistance (MR) of metals is one of the important methods used to explore their electronic structure and the scattering processes of their current carriers. It is customary to plot the Kohler diagram in order to compare the field dependence of MR of different purity samples of the same metal or of different metals. The Kohler's plot is based on Kohler's rule,

$$\frac{\Delta\rho}{\rho_0} = F(B/\rho_0) = [\rho(B) - \rho_0]/\rho_0$$

i.e., the fractional increase in resistance $\Delta\rho/\rho_0$ in the magnetic induction B of a specimen of resistivity ρ_0 at zero induction is a function only of the parameter B/ρ_0. The function F depends on the relative orientation of B and the measuring current J, and if the

specimen is a single crystal, on the cyrstal orientation. Chamber[1] has discussed the validity of the Kohler's rule and suggested that the Kohler's rule is valid provided that a relaxation time approximation can be made, that changes in ρ_0 give rise to negligibly small changes in electron band structure details and finally that changes in ρ_0 result only in changes in the magnitude of the relaxation time τ and not in the form of dependence on k. It is important to note that the Kohler's rule is not valid in metals exhibiting magnetic breakdown (MB) effect since the effective relaxation time of the carriers becomes field dependent and hence is no longer proportional to ρ_0.

There have been polycrystal magnetoresistance results for Ni[2,3] and Fe[4] based alloys with a view to studying the validity of Kohler's rule. From the study of scattering-center effects in the MR of Ni it has been concluded that the form of the Kohler's function F depends on the dominant scattering center, *i.e.*, the form of τ (k) corresponding to two different scattering centers gives rise to two differing form of the function F in the Kohler's rule. The results on iron samples doped with different amounts of Co and Cr impurities also show that the form of the Kohler's function depends on the type of scattering center.

In the present paper Kohler's rule is studied in iron whiskers at high magnetic fields. The purpose is to understand the role of electron scattering processes and magnetic breakdown field in MR and to see what additional insight one gets from measurements on single crystals.

Experimental Details and Results

High purity iron whiskers (RRR 700 to 7000) were grown by Bergman technique. Most of the iron whiskers were single crystals with their crystallographic axis along ⟨100⟩ and ⟨111⟩. We have used the standard 4-terminal DC method to plot MR anisotropy curves. Superconducting magnetic fields up to 109 kG was used for these measuremonts. The details of experimental measurements can be found elsewhere[5,6].

The reduced Kohler plots for different purity ⟨100⟩ and ⟨111⟩ whiskers are shown in Fig. 1 (*a*) and (*b*) respectively. These plots are based on the field dependence of the MR along the deep minima, *i.e.*, for B ∥ [010] and in (100) and for B ∥ [110] and in (100). The data for ⟨100⟩ and ⟨111⟩ whiskers lies on the same curve for high purity whiskers but deviate considerably for the low purity whiskers.

Discussion

The observed deviations from Kohler's rule can be due to the presence of MB, the samples of different purity containing different kinds of impurities

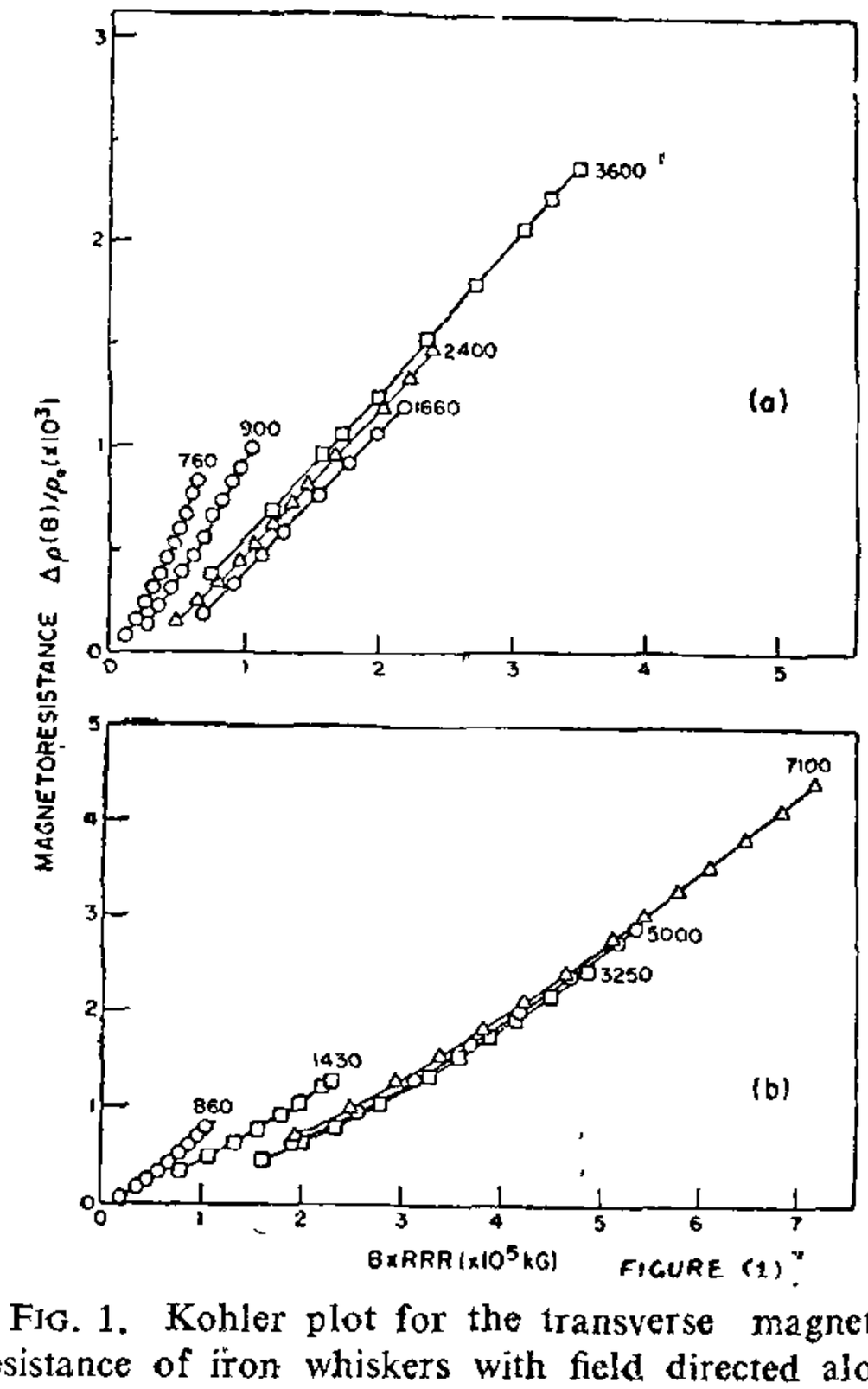

FIGURE (1)

FIG. 1. Kohler plot for the transverse magnetoresistance of iron whiskers with field directed along the deepest minima of the magnetoresistance anisotropy curve. The value of RRR is given next to the curve or each sample : (*a*) ⟨100⟩ whiskers; (*b*) ⟨111⟩ whiskers.

as seen in the case of polycrystalline samples, or each low purity samples may be containing different kinds of impurities in comparable concentrations. Also there is the possibility of field dependent scattering processes such as those associated with localized magnetic moment, which may also give rise to deviations from Kohler's rule.

In our samples Mn was the major source of impurity. So the observed deviation from Kohler's rule cannot be ascribed to the different types of impurities in the different low purity samples.

The calculations of Falicov and Sievert[7] show that in the presence of MB the resistivity tensor as a function of $\omega_c \tau$ (ω_c is the cyclotron frequency) does not scale with the parameter $\omega_0 \tau$ (ω_0 is the frequency associated with the MB field). This gives rise to a dependence of the shape of the curves on the purity of the sample. The parameter $\omega_0 \tau$ for different purity samples (with the same kind of impurity) can be different due to either different values ω_0, τ or both. The speculation of ω_0 being different for different

purity samples is based on the possibility of modification of breakdown field in the presence of strong scattering. This effect of modification of breakdown field in the presence of strong scattering has been investigated recently[7] in Zn based alloys and it has been concluded that the presence of strong scattering appreciably modifies the magnitude of the breakdown field. In view of this we believe that the dependence of the shape of the curves on the purity of the samples may be due to different values of $\omega_0\tau$. A more detailed theory of MR of ferromagnetic metals which includes the effect of scattering on MB is being worked out. On the experimental side more experiments on single crystals of ferromagnetic metals containing controlled concentrations of different kinds of impurities is necessary. Then the deviations from Kohler's rule may well yield useful information on the role of electron scattering processes and MB in transport properties.

The experimental work of this note was carried out at the Department of Physics, University of Toronto Canada, and forms part of the Ph.D. thesis of MAA.

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PRELIMINARY X-RAY STUDIES ON N-ACETYLGLYCYL-L-LYSINE METHYL ESTER ACETATE, L-ARGININE L-ASPARTATE AND L-ORNITHINE L-ASPARTATE

ONE approach to the study, at the atomic resolution, of the geometrical features of the non-covalent interactions important in the structure, assembly and function of proteins is through the preparation and x-ray analysis of crystalline complexes involving amino acids and short peptides among themselves as well as with other molecules. As a part of a programme of structural investigations on such complexes[1,2], we report here the preliminary x-ray studies on the crystals of N-acetylglycyl-L-lysine methyl ester acetate (NAGLA), L-arginine L-aspartate and L-ornithine L-aspartate.

Samples of the three complexes were commercially available from Sigma Chemicals, U.S.A. NAGLA was crystallized by the slow evaporation of a solution in methanol whereas the crystals of arginine aspartate and ornithine aspartate were grown by liquid diffusion with water as the solvent and *n*-propanol as the precipitant. The space group and the unit cell dimensions were determined from x-ray diffraction photographs and subsequently refined on a four-circle CAD-4 diffractometer. The densities of the crystals were determined by flotation in a mixture of benzene and carbon tetrachloride. The crystal data and the densities are given in Table I.

TABLE I

Crystal data

	NAGLA	L-arginine L-aspartate	L-ornithine L-aspartate
Space group	$P2_12_12_1$	$P2_1$	P1
a in Å	5·511 (2)	5·510 (2)	4·718 (1)
b in Å	14·558 (4)	8·438 (4)	11·181 (2)
c in Å	21·109 (4)	15·265 (9)	12·653 (2)
α in degrees	..	..	102·8 (1)
β in degrees	..	97·9 (1)	100·7 (1)
γ in degrees	..	..	77·8 (1)
No. of formula wts. in the unit cell	4	2	2
Measured density in gm/cc	1·246 (8)	1·467 (8)	1·446 (8)
No. of solvent (water) molecules in the unit cell	..	..	1
Calculated density in gm/cc	1·252	1·452	1·450

The structure analysis of the complexes is in progress.

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