Comments and Addenda

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Hall effect in amorphous $La_{1-x}Ga_x$ foils

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Values of the Hall coefficient for $La_{1-x}Ga_x$ "splat-cooled" foils with $x = 0.16$, 0.20, 0.22, and 0.26 are presented. The Hall coefficient is positive for this system like that of liquid La and exhibits a temperature dependence which correlates with the temperature coefficient of resistance.

The properties of "splat-cooled" foils of the $La_{1-x}Ga_x$ system have been extensively studied in the range $x = 0.16-0.28$ where an amorphous phase has been stabilized.[1] These studies have determined the superconducting transition temperatures, temperature dependences of the critical fields, electrical resistivities, mass densities, and low-temperature heat capacities as a function of x. In an effort to more fully characterize this system we reported values of the Hall coefficient for amorphous $La_{0.8}Ga_{0.2}$[2] and now extend these measurements to three other alloys in this system with $x = 0.16$, 0.22, and 0.26.

These alloy samples are from a batch prepared and structurally characterized by W. L. Johnson at California Institute of Technology and are essentially identical to those studied in Ref. 1. The experimental technique for the Hall-effect measurements is the same as that previously described.[2]

The values of the Hall coefficient for the amorphous $La_{1-x}Ga_x$ foils as well as previously published values for pure La in both the lower-temperature crystalline phase[3] and in the high-temperature phases around the melting point[4] are summarized in Fig. 1. The largest error in R_H for the $La_{1-x}Ga_x$ foils arises from the uncertainty in determination of the foil thickness. Consequently, the absolute magnitude of R_H for these foils is uncertain by about 20%. However, the relative precision of the data points for any given sample with a specific Ga concentration, which determines the temperature dependence of R_H for that sample, is about 5% of the measured value and is determined by electrical noise and the stability of the electrical contacts.

As may be seen from Fig. 1, R_H is positive for the amorphous alloys and exhibits appreciable temperature dependence. The temperature dependence of R_H has the same sign as that reported for the electrical resistivity of these samples.[1] A reasonable extrapolation of the temperature dependence would lead to a value of R_H close to that of either the pure liquid or the high-temperature bcc phase. The Hall coefficient generally appears to increase with increasing Ga content for $x \leq 0.22$. Because of the large uncertainty in absolute values of R_H, it is impossible to determine if this trend reverses, continues, or saturates for $x = 0.26$.

At present there is no satisfactory explanation of the positive Hall coefficient in either the amorphous or the liquid phase. As shown by Ballentine[5] any

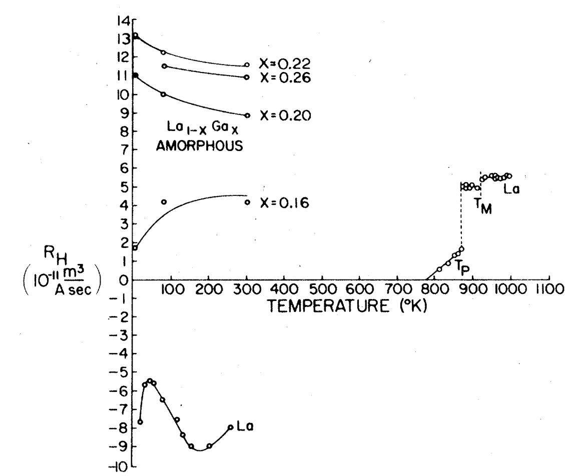

FIG. 1. Hall coefficient for amorphous $La_{1-x}Ga_x$ alloys as compared with that for crystalline and liquid phases of La.

nearly free-electron model should result in a negative value unless dE/dk is negative in which case the carriers behave as free holes. We do not choose to speculate as to whether mechanisms such as spin-orbit scattering could explain such large positive values, but to date no calculations exist which predict this for liquid or amorphous La. The temperature dependence is also anomalous but so is that of crystalline La.

More precise measurements of R_H for this system are desirable. We are considering the possibility of using measured densities together with the weights of the foils to improve the thickness determinations which are the major source of error and the possibility of performing the experiments on evaporated thin-film alloy samples with an inherent thickness uncertainty of 5–10%. Studies of thermopower in this system have commenced and results should be available soon.

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