CHARGE DENSITY WAVE TYPE BEHAVIOUR OF THE LOW TEMPERATURE SUPERSTRUCTURE IN MANGANITES

S. Cox, R.D. McDonald, J. Singleton (NHMFL, Los Alamos), P.B. Littlewood (Cambridge University)

Introduction

Many strongly correlated electron systems exhibit charge ordering phenomena, in which a superstructure forms at low temperatures. Historically it was thought that the superstructure formation was driven by charge separation and localisation at atomic sites [1]. However, recent work has produced conflicting evidence as to the nature of the superstructure, with some studies indicating that the superstructure is not tied to the atomic sites, leading to the suggestion that the superstructure resembles a charge density wave [2]. In this report, we probe the nature of the superstructure via resistance measurements.

Previous resistance measurements in $La_{0.5}Ca_{0.5}MnO_3$ failed to uncover any interesting behavior. Firstly, most studies were performed using polycrystalline samples in which grain boundary effects might be supposed to dominate, and secondly those studies using thin films did not use a separate technique to independently verify the presence of the superstructure. Here we perform resistance measurements on a thin film sample of $La_{0.5}Ca_{0.5}MnO_3$ on $NdGaO_3$ in which the presence of a uniaxial superstructure has been verified using low temperature transmission electron microscopy (TEM).

Experimental

The sample was cooled in the VTI of the 17 T GHz magnet. Using a precision current source, a DC current was applied, with a superimposed AC current at 17 Hz. The differential resistance of the sample was monitored and the DC current was changed. The experiment was performed with the current flow parallel and perpendicular to the superstructure.

Results and Discussion

When the current was passed parallel to the wavevector of the superstructure a large drop in the differential resistance was recorded when compared to the drop over the same applied electric field in the direction perpendicular to the superstructure (see Fig. 1). In addition, there was a large hysteresis between the first time the current was applied in the direction of the superstructure and subsequent sweeps. This hysteresis could consistently be reestablished by thermally cycling via 300 K.

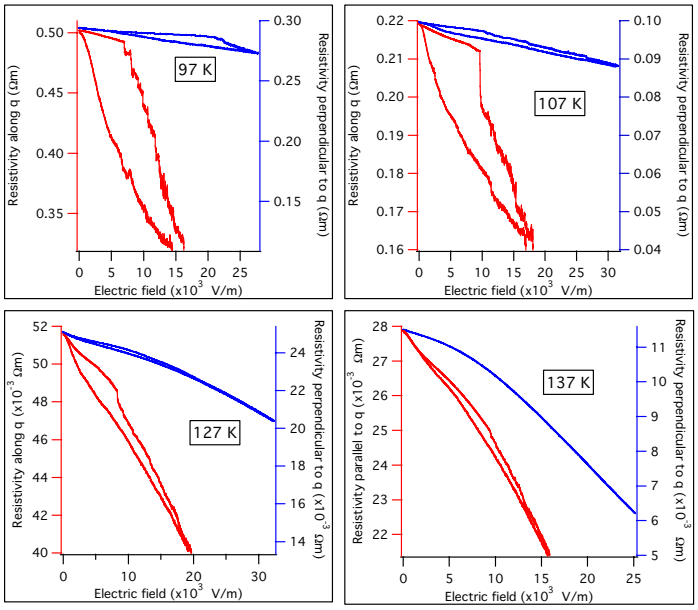

Figure 1: Variation of differential resistance with applied electric field parallel (red) and perpendicular (blue) to the superstructure.

Conclusions

The thin film of $La_{0.5}Ca_{0.5}MnO_3$ exhibits unusual resistance properties which can be correlated with the properties of the superstructure. The fact that the resistance drop in the superstructure direction is so much larger than the non-superstructure direction hints at depinning in the system and provides support to the CDW model of the superstructure.

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References

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