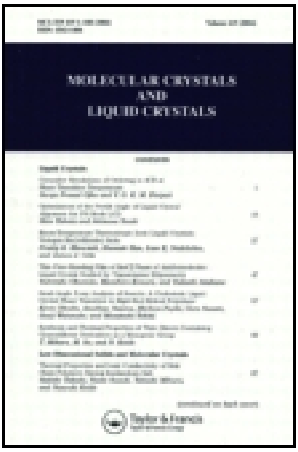

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EPR Spectroscopic Study of Iron Arachidate Langmuir-Blodgett Multilayers

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EPR SPECTROSCOPIC STUDY OF IRON ARACHIDATE LANGMUIR-BLODGETT MULTILAYERS

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Abstract We investigate the two dimensional antiferromagnetic ordering in ferric arachidate $(Fe-(COO-(CH_2)_{18}-CH_3)_3)$ Langmuir–Blodgett layers. Electron paramagnetic resonance is an adequate method to study this behaviour. Our results show an evidence for antiferromagnetic ordering.

INTRODUCTION

In recent years there has been an increasing interest in the behaviour of two-dimensional objects.

The dimensionality plays an important role in studying the quantum Heisenberg antiferromagnet. In one dimension (1D) the Heisenberg model can be solved exactly[1]. In three dimensions, the spins can be ordered antiferromagnetically below Néel temperature, and spin–wave theory[2] is generally accepted as a proper representation of the excitation spectrum at low temperatures.

The situation in two dimensions is much less clear. The aim of this paper is to investigate experimentally the two dimensional antiferromagnetic ordering.

One of the experimental realization of such samples is the Langmuir–Blodgett (LB–) technique. The LB–films consist of a definite number of layers of uniformly oriented long chains of hydrocarbons which can bind for example metal ions on the polar headgroups.

In this paper we report a study of ferric arachidate $(Fe-(COO-(CH_2)_{18}-CH_3)_3)$ multilayers by EPR spectroscopy.

Earlier Mössbauer spectroscopic investigations of these multilayers[3] raised the possibility of an ordering of antiferromagnetic character at low temperatures in two dimension. The EPR spectroscopy is an adequate method to study this behaviour.

EXPERIMENTAL

The Langmuir–Blodgett film was prepared on a glass substrate (172 layers on both sides) in a conventional Langmuir-Blodgett trough by dipping technique from arachidic acid on subphase of 5×10^{-5} M $FeCl_3$ in pure water.

EPR measurements were made by a Brucker 300 CW spectrometer operating at 9.4 GHz in the temperature rage of 7 to 293 K.

RESULTS AND DISCUSSION

The EPR spectra show tree different environments of iron ions.

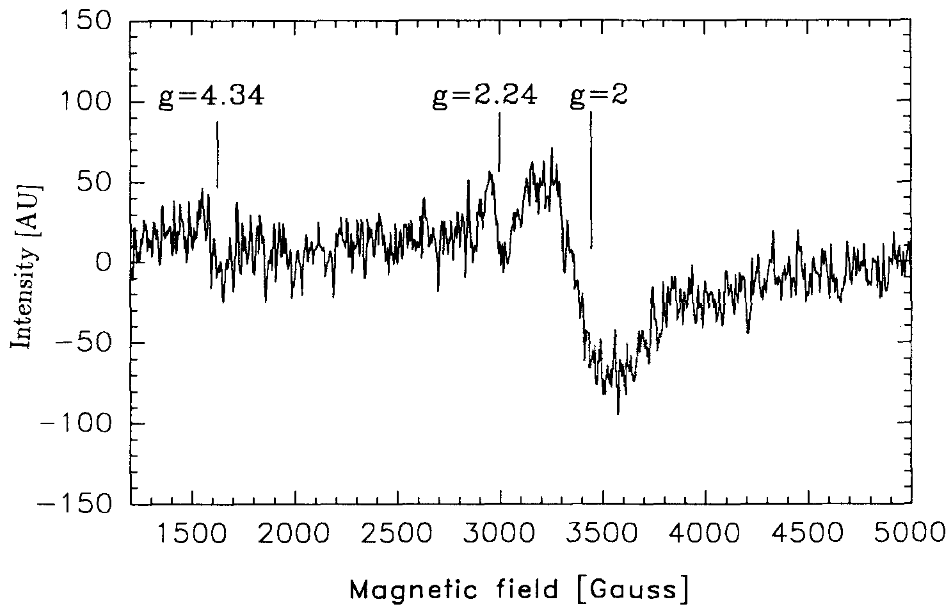

FIGURE 1 The EPR Spectrum of iron–arachidate LB–film

The main part of the spectrum is a broad line at g=2 which grows in intensity as the temperature is lowered. The width of this line changes slightly with temperature, but typically it is about 330 G.

This broadening is probably caused by dipolar interaction between iron ions. The line intensity increase do not follow the Curie-law (linear increase with reciprocal temperature). Below 100 K a drop can be observed.

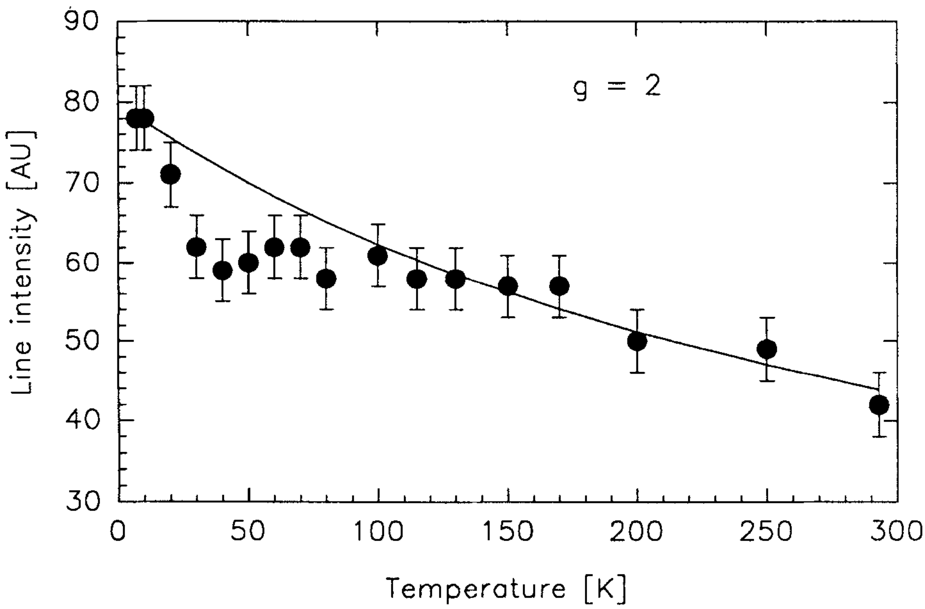

FIGURE 2 Temperature dependence of line intensity at g=2

An anisotropic line appears at g=4.34. This line is characteristic of isolated high-spin ferric ions ($d^5, S = \frac{5}{2}$) in rhombic environment. The line intensity is very low and follows the Curie-law down to $\sim$ 7 K.

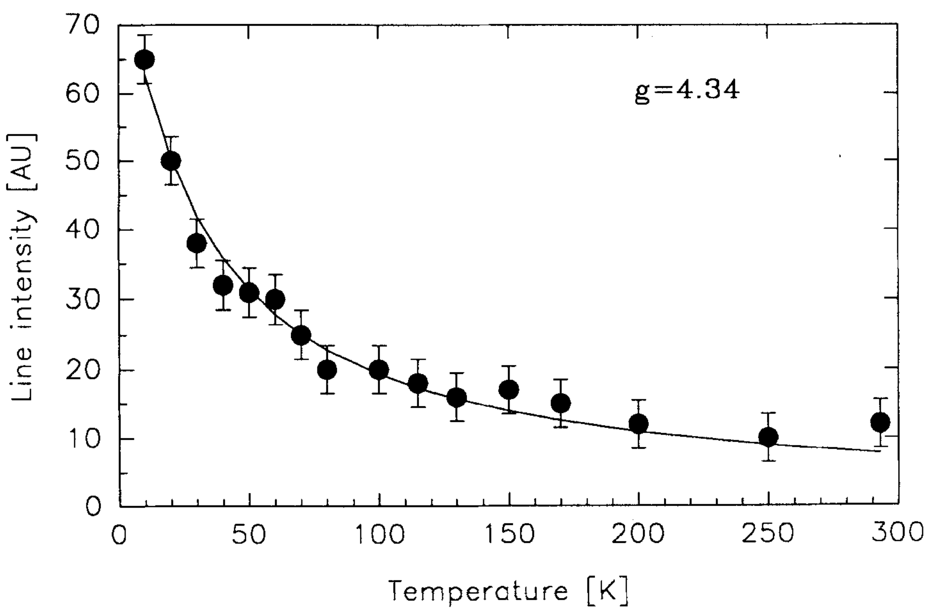

FIGURE 3 Temperature dependence of line intensity at g=4.34

The most interesting part of the spectrum is at g=2.24. The integral intensity of this line is about 1% of that of line at g=2. The line intensity increases by decreasing temperature above 125 K. The line slowly diminishes below this temperature.

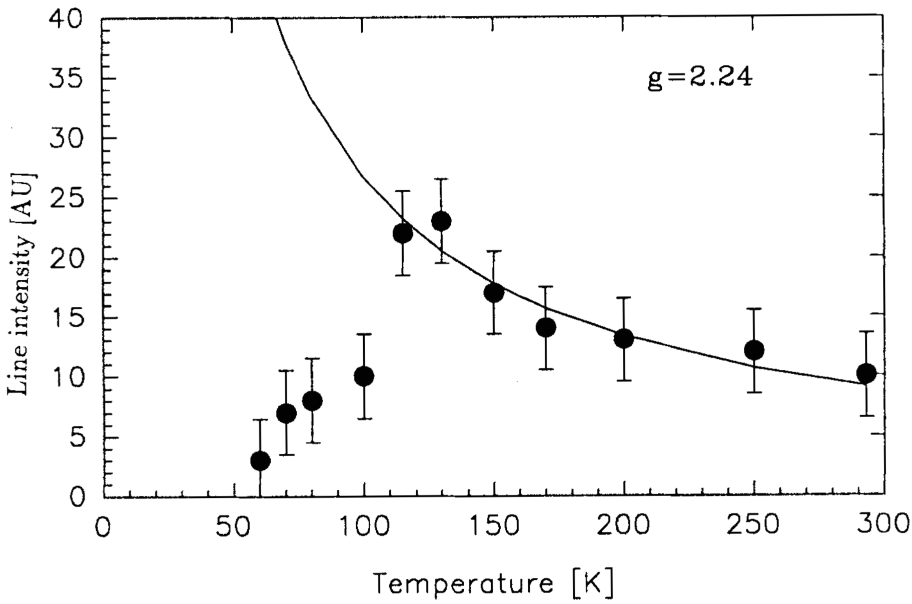

FIGURE 4 Temperature dependence of line intensity at g=2.24

This is in fair agreement with a possible appearance of an antiferromagnetic arrangement in the layers at lower temperatures. Further investigations are going on to understand the differently arranged regions of the sample.

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