Magnetic measurements in double perovskite Ca_2FeMoO_6 single crystal minirods

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Abstract

Single crystals of double perovskite Ca_2FeMoO_6 have been grown by the laser-heated pedestal growth (LHPG) technique and their magnetic properties have been characterized by measurements of susceptibility versus temperature and field dependence of magnetization.

Introduction

Some members of the double perovskite family with composition A_2FeMoO_6 (A=Ba,Ca,Sr) have been reported as an alternative to perovskite manganites [3]. The obtention of these double perovskite as single crystals, however, is difficult through conventional growth methods and because of that most chacterization of their magnetic properties has been made in films and bulk ceramics. Polycrystalline Ca_2FeMoO_6 is a double perovskite that exhibits increase of magnetoresistance from 16.7% to 44.2% between 4 K and 300 K at a magnetic field of 7 T. This increase is larger than that of Sr_2FeMoO_6 (T_C = 420 K) at the same corresponding extreme temperatures and applied magnetic field. This makes Ca_2FeMoO_6 attractive enough for immediate colossal magnetoresistance-related applications, and availability of their single crystals is not only useful but convenient to better study their magnetotransport properties [1-9].

In this work, we report on the growth of high single crystal quality Ca_2FeMoO_6 and its magnetic characterization at room temperature by electron paramagnetic resonance at 9.4 GHz.

Experimental

The crystals were grown in isostatic inert atmosphere (ultrapure N_2) at a specific pressure range (0.25-0.50 atm), using unreacted starting reagents and the growth technique known as laser-heated pedestal growth (LHPG) that leads to single crystals with the geometry of minirods. The full procedure to grow the single crystals is found in refs. [10] and [11].

The magnetic measurements were carried out on a Quantum Design MPMS-XL SQUID (superconducting quantum interference device) susceptometer.

Results

Fig. 1 shows the susceptibility as a function of temperature with the applied magnetic field parallel and perpendicular to the crystal axis. The Curie temperature is T_C = 380 K. This value is in agreement with that obtained by other authors in polycrystalline sample.

At *T* = 20 K the magnetic susceptibility with field perpendicular to the crystal axis decreases, while along the crystal axis increase up to *T* = 2 K.

The dependence of magnetization with the magnetic field (Fig. 2) at 5 K, 100 K and 300 K are typical of a ferrimagnet material with a saturation magnetic moment of approximately 2.1 μB , 2.0 μB and 1.4 μB per formula unit, respectively.

There are not large differences between curves of *M* versus *H* applied in both directions. Coercivity field is low typical of 30 Oe. The ideal ferrimagnetic configuration $3d^{5}\uparrow$ - $4d^{1}\downarrow$ yields a moment of 4μB/formula.

The measured resonance line fits a gaussian function with linewidth of about 1800 G, and resonance field of 3500 G, typical of predominant presence of Fe^{2+} ions, in agreement with expected valence of iron in the compound.

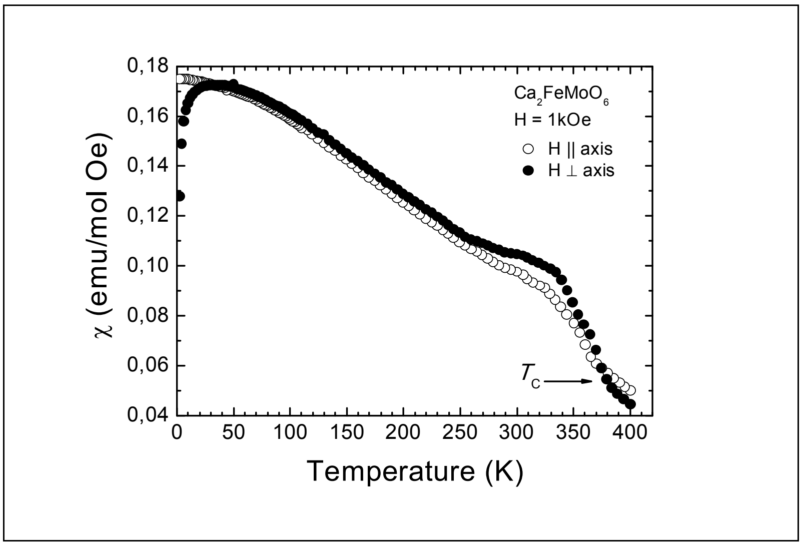

Figure 1: Magnetic susceptibility as a function of temperature for Ca_2FeMoO_6 with *H* = 1 kOe applied in two crystallographic directions.

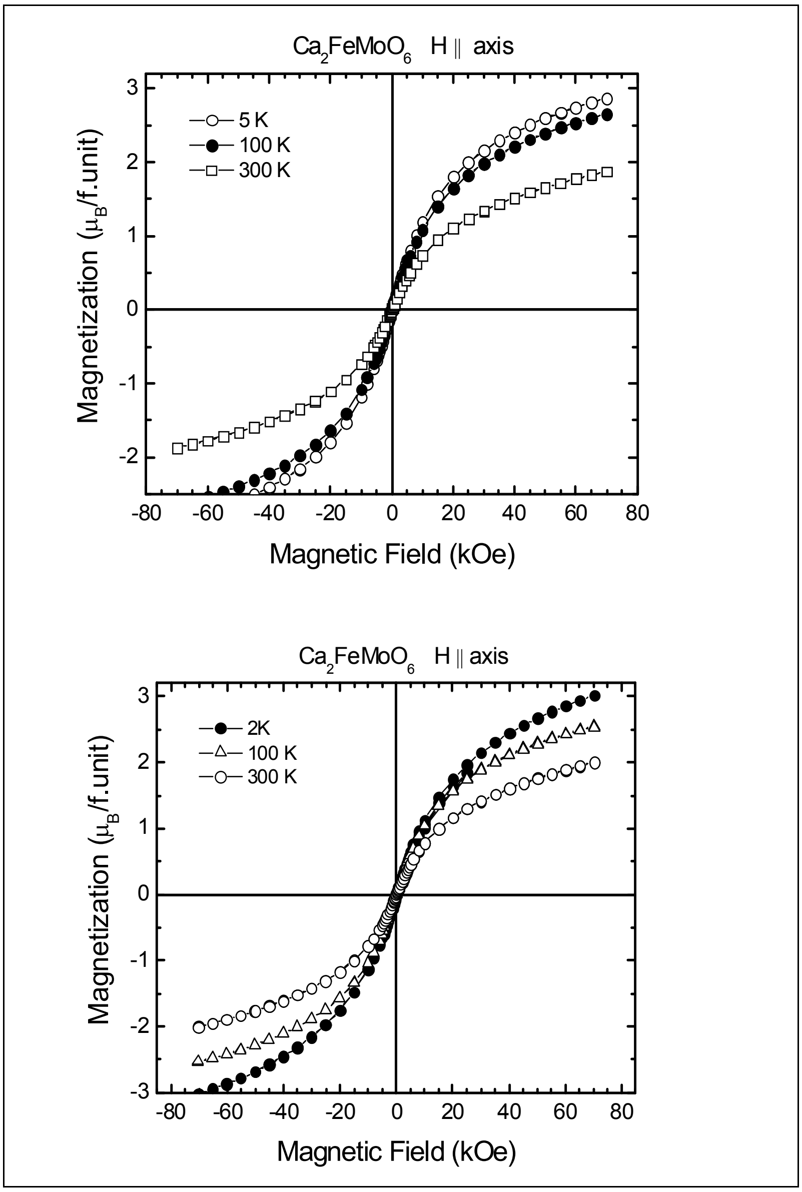

Figure 2: Field dependence of magnetization for Ca_2FeMoO_6 single crystals at $T = 2$ K, $T = 5$ K, $T = 100$ K and $T = 300$ K, along different axes referred to the growth axis.

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