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# Material Design and Growth of "Zinc-Blende CrAs"

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## 1. Introduction

The epitaxial growth of various magnetic thin films on semiconductors has become a popular technique owing to the development of molecular beam epitaxy (MBE). Especially, the growth of manganese pnictides such as MnAs[1], MnSb[2], and MnBi[3] on GaAs substrates has attracted great attentions due to the possibility of applications to 'spin-electronic' devices. We have already predicted by theoretical calculations that a zinc-blende (zb) type CrAs has a half-metallic band structure and the ferromagnetic state is most stable[4]. We have succeeded in growing zb-CrAs thin films on GaAs surfaces[5]. In this contribution, the growth of zb-CrAs thin films depending on the substrate temperature and their magnetic characteristics are reported.

## 2. Experimental

Zb-CrAs films were grown on the GaAs (001) surface by MBE. After the growth of a GaAs buffer layer, CrAs thin films were grown at 150, 200, and 300° C. Surface morphologies during the growth were monitored by reflection high-energy electron diffraction (RHEED). Magnetic properties of the zinc-blende CrAs film grown at 200° C was investigated by a superconducting quantum interference device (SQUID).

## 3. Results and Discussions

When the CrAs film was grown at 150° C, the RHEED pattern changed to the halo pattern gradually, which indicates the formation of amorphous CrAs. The RHEED pattern during the growth of CrAs at 200° C maintained the streaky pattern of zinc-blende type. These streaks remained until the growth of 3 nm CrAs, and an unknown phase appeared above the critical thickness. On the other hand, the CrAs film grown at 300° C showed the different surface morphology. The RHEED pattern changed to the spotty pattern. This pattern is thought to indicate the three dimensional growth-mode of CrAs.

A capping layer of low-temperature GaAs was grown on the CrAs thin film in advance to prevent oxidation. Figure 1 shows a magnetization hysteresis curve of the film measured at 300 K. Ferromagnetic properties were observed even at room temperature. Magnetic moment per formula unit of CrAs estimated form the saturation magnetization agrees well with the theoretical prediction. We also measured magnetization as a function of temperature. The Curie temperature of the film is expected to be higher than 400 K.

## 3. Conclusions

Epitaxial zinc-blende CrAs thin films were grown at two different temperatures. CrAs (2 nm) grown at 200° C maintained the zinc-blende structure from GaAs, whereas CrAs (2 nm) grown at 300° C formed island structures. When CrAs was grown at 150° C, the amorphous Cr-As compound was obtained. The thin film grown at 200° C showed ferromagnetic behavior at room temperature, and the Curie temperature was estimated to be over 400 K.

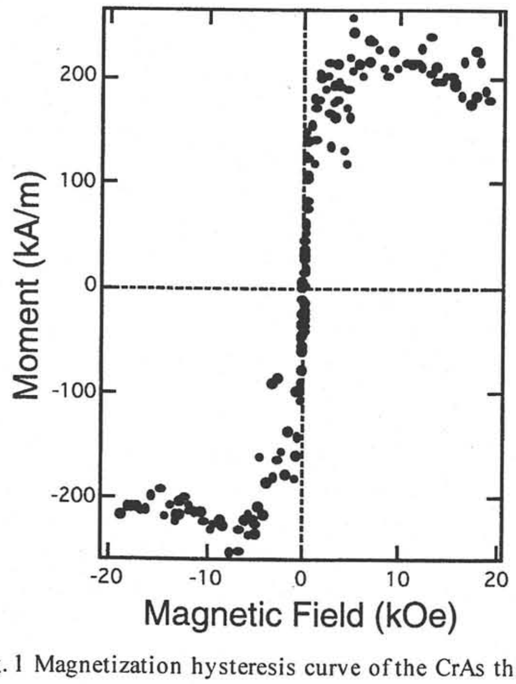


Fig. 1 Magnetization hysteresis curve of the CrAs thin film (2 nm) grown at 200° C. The measurement was performed at 300 K.

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