Magnetic properties in magnetron sputtering prepared ZnO thin films

Y. Zhang, N. Nasu, and X. Zhao

Dept. of Physics, Tokyo University of Science, 1-3 Kagurazaka, Shinjuku-ku, Tokyo 162-8601,Japan

E-mail: xwzhao@rs.kagu.tus.ac.jp

INTRODUCTION

Diluted magnetic semiconductors which are semiconducting materials in which a fraction of the host cations can be substitutionally replaced by magnetic ions or appropriate rare earths have become a hot topic because of their potential applications in spintronics. Since the prediction that Mn-doped p-type ZnO is one of the most promising candidates for ferromagnetic DMSs with high curie temperature by Dietl[1] in 2000, it has been difficult to achieve ZnO:Mn thin films which got room temperature ferromagnetic properties and the mechanism of the ferromagnetism has also been an issue of debate. Some of the studies found that even the undoped ZnO materials can show ferromagnetic properties[2]. In this work, we prepared the ZnO thin films which showed hysteresis loops till room temperature by rf magnetron sputtering.

EXPERIMENT

The ZnO thin films of 100 nm were deposited on SiO_2/p-Si(100) substrates at 300 ºC for 1 h with pure ZnO target. After depositing, this sample was annealed at 500 ºC for 5 min at the flow rate of 5 ml/min in oxygen atmosphere. The X-ray diffractometer (XRD) was used to measure the samples to obtain the X-ray diffraction curves. Magnetic properties of the samples were studied with a superconducting quantum interference device (SQUID).

RESULT

Figure 1 shows the XRD patterns of the sample and the monocrystal ZnO thin film. The diffraction peaks from the ZnO wurtzite structure were observed, indicating no secondary phase existed and the Mn ions were doped into ZnO. Figure 2 shows the M-H curves when the magnetization loops for the samples were measured at different temperatures (5K, 50K and 300K) by using SQUID. The results present that A500 sample showed hysteresis loops till 300K while the monocrystal ZnO showed different magnetic property. The other results and conclusion will be discussed on site.

[1] T. Dietl, H. Ohno, F. Matsukura, J. Cibert,D. Ferrand. Science 287,1019-1022(2000).
[2] M. A. Garcia, J. M. Merino, E. Ferna´ndez Pinel, A. Quesada, J. de la Venta, M. L. Ruı´z Gonza´lez, G. R. Castro, P. Crespo, J. Llopis, J. M. Gonza´lez-Calbet, and A. Hernando, Nanoletters 6,1489-1494 (2007).

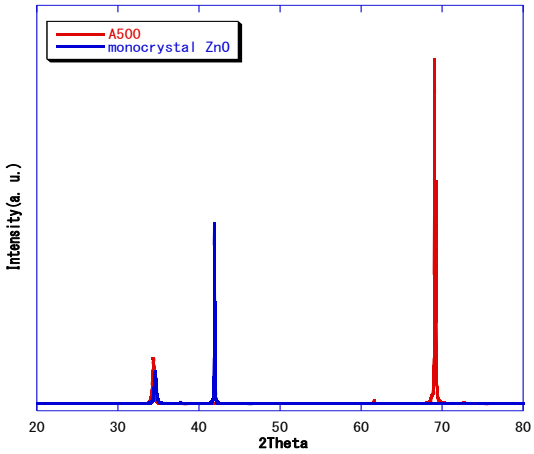

Fig. 1. XRD patterns of ZnO thin films.

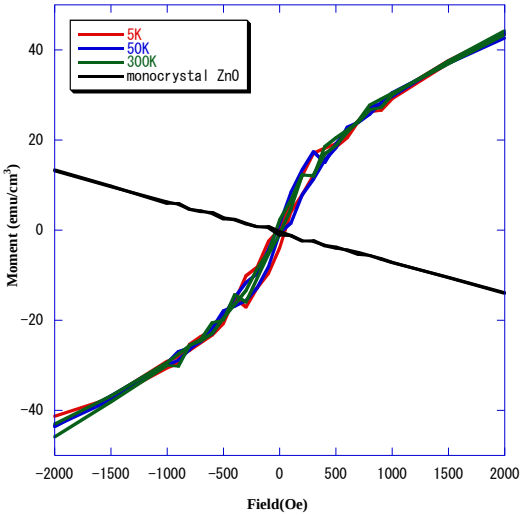

Fig. 2. M-H curves of ZnO thin films at 5K, 50K and 300K.