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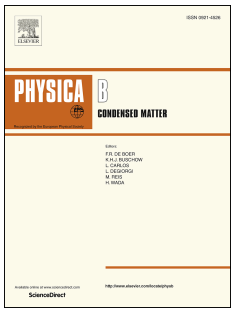

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Synthesis and magnetotransport studies of CrO_2 films grown on TiO_2 nanotube arrays by chemical vapor deposition

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Abstract

The CrO_2 films have been prepared on the TiO_2 nanotube array template via atmospheric pressure chemical vapor deposition method. And the growth procedure was studied. In the beginning of the deposition process, the CrO_2 grows on the cross section of the TiO_2 nanotubes wall, forms a nanonet-like layer. And the grain size of CrO_2 is very small. With the increase of the deposition time, the grain size of CrO_2 also increases, and the nanonet-like layer changes into porous film. With the further increase of the deposition time, all the nanotubes are covered by CrO_2 grains and the surface structure becomes polycrystalline film. The average grain size on the surface of the CrO_2 films deposited for 1 h, 2 h and 5 h is about 190 nm, 300 nm and 470 nm. The X-ray diffraction pattern reveals that the rutile CrO_2 film has been synthesized on the TiO_2 nanotube array template. The CrO_2 films show large magnetoresistance (MR) at low temperature, which should originate from spin-dependent tunneling through grain boundaries between CrO_2 grains. And the tunneling mechanism of the CrO_2 films can be well described by the fluctuation-induced tunneling (FIT) model. The CrO_2 film deposited for 2 h shows insulator behavior from 5 k to 300 K, but the CrO_2 film deposited for 5 h shows insulator-metal transition around 140 K. The reason is briefly discussed.

Keywords: CrO_2; TiO_2 nanotube array; Magnetoresistance; Chemical vapor deposition;

1. Introduction

Due to its particular magnetic and electrical properties, half-metal ferromagnet chromium dioxide (CrO_2) has caused extensive concern of researchers in spintronics. The spin polarization of the CrO_2 is 100% at the Fermi level as predicted by the theoretical research[1-3]. And this has been illustrated by means of spin-polarized photoemission and point-contact Andreev reflection experiments[4, 5]. CrO_2 would have vast development prospects as magnetic components in spintronics devices. For instance, it is an ideal candidate for magnetic tunnel junctions and spin valves on account of its nearly perfect spin polarization[6-8]. Large magnetoresistance (MR) is expected in ferromagnetic tunnel junctions with CrO_2 [9-11].

CrO_2 has been widely researched, especially CrO_2 films and nanostructures[12-20]. This is mainly due to the fact that CrO_2 films and nanostructures are of importance in spintronics applications. But it is difficult to synthesize CrO_2 films and nanostructures on account of the thermodynamically unstable