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Low Temperature Growth of Epitaxial $SrRuO_3$ Thin Films

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During a decade, there have been great interest in $SrRuO_3$ due to its scientific interest, such as intriguing itinerant ferromagnetism[1], and possible application, such as oxide electode[2]. Especially, lattice constant of $SrRuO_3$ is well matched with most of ferromagnetic oxide, e.g. $(La,Sr)MnO_3$ as well as ferroelectric oxide, e.g. $BaTiO_3$. Therefore, epitaxial growth of $SrRuO_3$ on suitable substrate is inevitable for the wide range of application by using oxides. While the epitaxial growth of $SrRuO_3$ at high temperature is well known[2], the low temperature growh is quite difficult and challenging work.

In this presentation, we used novel enhanced ionization technique, called Aurora Pulsed Laser Deposition (PLD) method.[3] We have succeed in epitaxial growth of $SrRuO_3$ thin film at as low as 400℃. By using HR-XRD, AFM, and SQUID measurement, we notice that the $SrRuO_3$ films grown by Aurora PLD method enhance the crystalline quality, surface morphology, and Curie temperature, respectively. We will discuss the role of magnetic field on electrical and magnetic properties of $SrRuO_3$ in conjunction with residual resistivity.

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Enhancement of Ordering Temperatures of $La_{0.67}Ca_{0.33}MnO_3$ Thin Films by Adding Ho Atoms

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Perovskite-type manganese based oxides have attracted a great deal of interest due to their very high magnetroresistance effect, so called the colossal magnetoresistance (CMR) observed near the Curie temperature (T_c). However, the Curie temperature of LCMO thin film is well below 260 K and a large CMR effect only appears at low temperatures. Consequently, it is very difficult to devise LCMO-based devices operating at room or higher temperatures. In this investigation, it has been found that the meta-insulator transition temperature (T_{MI}) and ferromagnetic ordering temperatures (T_c) can be significantly increased by adding proper amount of Ho in LCMO films. In contrast, the ordering temperature of Ho-doped films falls monotonously with increasing Ho content.

Ho_x-$La_{0.67}Ca_{0.33}MnO_3$ films with x = 0, 0.2, 0.4, 0.6 and 1.0 mole %of Ho have been deposited on $SrTiO_3(100)$ substrates with the substrate temperature controlled at 600℃ by dc magnetron sputtering. The thickness of the films was about 30 nm. It has been found from x-ray diffraction that only superlattice peaks corresponding to (002) and (004) planes were present and the peak positions did not change as the amount of Ho is added. Furthermore, T_c and T_{MI} were enhanced about 25 ~ 60K for Ho-$La_{0.67}Ca_{0.33}MnO_3$ films compared with Ho-free LCMO thin film. At x ≒ 0.4 the ordering temperature has been enhanced above 280K. Further increasing amount of Ho will depress the ordering temperatures. The chemical compositions of the films were determined by an electron spectroscopy for chemical analysis (ESCA). The relative composition of La and Ca were about the same within a narrow range for all films studied. Thus, the variation of the ordering temperature is simply ascribed to the presence of Ho. The XPS spectra of Ho 4d of Ho-added samples indicated that the peak has been shifted from its original value 159.6 eV to higher binding energy of 161.7 eV. It was observed that the Ho 4d peak of Ho added sample was identical to the Ho 4d peak of Ho_2O_3, suggesting that Ho in our samples is present in oxide form. The magnetoresistance was measured by conventional four-probe method. The CMR of the films was calculated by the following formula: $CMR(\%) = 100(R_H - R_0)/R_H$ where R_0 and R_H are resistances measured in zero and in the applied field of 0.5 Tesla, respectively. And T_P is defined to be the the temperature where CMR is a maximum, and found to rise with increasing applied field. It is noted that T_P exhibits the same trend as that of T_{MI}. The origin of Ho adding effect on CMR will be given in this presentation.

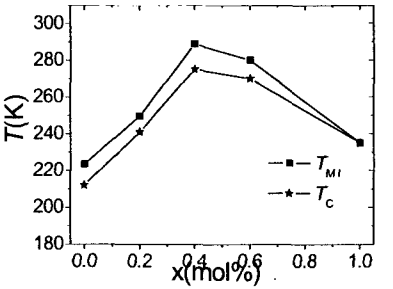

Fig. 1. The transition Temperatures, T_{MI} and T_c, as a function of x.

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