TDTR 法による La ドープ $BaSnO_3$ 薄膜の電子移動度調査

Investigation of the Electron Mobility in La-doped $BaSnO_3$ films using Time-Domain Thermoreflectance (TDTR) Method

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La-doped $BaSnO_3$ (LBSO, E_g~3.5 eV) is one of the most intensely studied transparent oxide semiconductors since its bulk single crystal exhibits a very high electron mobility of 320 $cm^2\ V^{-1}\ s^{-1}$ [1], which is comparable to that of doped silicon (~350 $cm^2\ V^{-1}\ s^{-1}$) [2]. However, the electron transport properties of the reported LBSO thin films are strongly suppressed compared to single crystal values (< 100 $cm^2\ V^{-1}\ s^{-1}$) [1]. While most studies attribute this phenomenon to the threading dislocations originated from the lattice mismatch at film/substrate, our studies suggest that the electron transport properties of LBSO films are also strongly dependent on the film thickness [3] and possibly the oxygen deficiency [4], which is seemingly high at the film/substrate interface. Since oxygen deficiency affect lattice vibrational properties, in this research, we further investigate the possibility of oxygen deficiency in the LBSO films with their thermal transport properties, which will be of great value in clarifying the thickness dependence of electron mobility in LBSO films. The LBSO films were grown epitaxially on (001) MgO substrates by pulsed laser deposition (PLD). The oxygen deficiencies in the LBSO films were controlled by changing the oxygen atmospheres during the film growth from oxygen (O_2) to ozone (O_3), and the thermal transport properties were characterized using TDTR. The through-plane thermal conductivity values exhibited a noticeable thickness dependence like their electron transport properties [3], which implies that the lattice defects exhibit a thickness gradient. In addition, the thermal conductivity of O_2-fabricated LBSO films (O_2-LBSO) were lower compared to that of O_3 fabricated LBSO films (O_3-LBSO) (**FIG.**). This is likely attributed to the oxygen vacancies since the main difference between the films was the oxidation condition. Furthermore, the Kapitza resistance of the O_2-LBSO/MgO interface was lower than that of O_3-LBSO/MgO interface, indicating that the interfacial bonding strength of O_2-LBSO/MgO interface is stronger than that of O_3-LBSO/MgO interface.

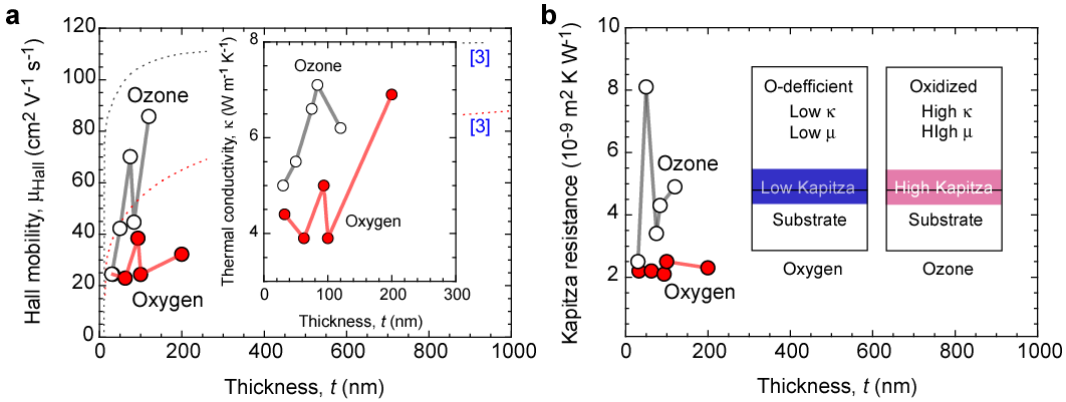

FIG. (a) Thermal conductivity of the LBSO films and (b) Kapitza resistance of LBSO-MgO interface.

References

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