La ドープ $BaSnO_3$ 薄膜の電子移動度抑制の起源(I)

Origin of Mobility Suppression in La-doped $BaSnO_3$ Films (I)

北大院情報[1], 北大電子研[2], 東大総研[3], 釜山大物理[4] ○魏 冕[1], サンチェラ・アナップ[2], 馮 斌[3], 李 浚赫[4], 金 高韻[4], 陳 亨秦[4], 幾原雄一[3], 太田裕道[1,2]

IST-Hokkaido Univ.[1], RIES-Hokkaido Univ.[2], Univ. Tokyo[3], Pusan Natl Univ.[4],

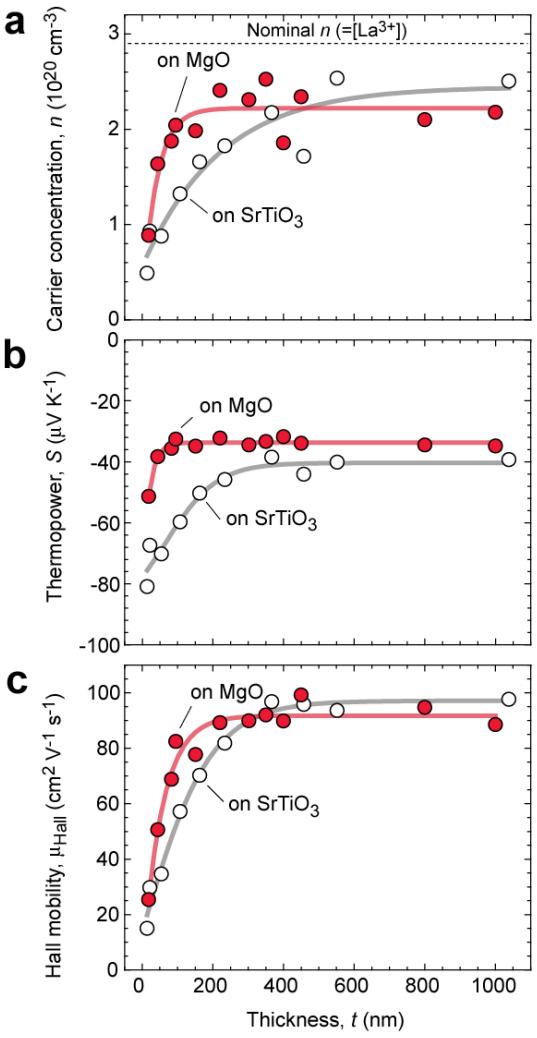
°M. Wei[1], A. V. Sanchela[2], B. Feng[3], J. Lee[4], G. Kim[4], H. Jeen[4], Y. Ikuhara[3], and H. Ohta[1,2]

E-mail: mian_wei@eis.hokudai.ac.jp

La-doped $BaSnO_3$ (BLSO, *Pm*-3*m*, *a*=4.115 Å, E_g~3.1 eV) single crystal exhibit very high mobility of 320 $cm^2\ V^{-1}\ s^{-1}$.[1] Therefore, BLSO has attracted increasing attention as a novel transparent oxide semiconductor for advanced transparent electronic devices. Recently, many researchers were trying to realize high mobility BLSO thin films. However, the reported mobilities are still far lower than that of single crystals. The origin of mobility suppression of BLSO was considered boundary scattering at columnar domain boundaries, which are generated due to the lattice mismatch (eg. $SrTiO_3$ +5.4 %). In order to minimize the lattice mismatch, Lee *et al.* used $BaSnO_3$ single crystals as the substrates. However, the resultant mobilities were <100 $cm^2\ V^{-1}\ s^{-1}$, [2] suggesting that the main origin is NOT lattice mismatch.

In order to clarify the main origin of the mobility suppression, we measured the electron transport properties of the BLSO ($Ba_{0.98}La_{0.02}SnO_3$) epitaxial films with varied thickness (20−1000 nm), which were grown on (001) $SrTiO_3$ (Δa=+5.4 %) or (001) MgO (Δa=−2.3 %) by PLD. **Figure** summarizes (a) the carrier concentration (*n*), (b) thermopower and (c) Hall mobility (μ_{Hall}) of the resultant films as a function of the BLSO thickness at room temperature. Regarding the overall tendencies, no clear difference is observed on $SrTiO_3$ and MgO substrates. The *n* increases with thickness and approaching to the nominal *n* (=[2.87×10^{20} cm^{-3}]). The *S* changes simultaneously with *n*. The μ_{Hall} also increases with thickness and reaches the maximum value of ~100 $cm^2\ V^{-1}\ s^{-1}$.

These results clearly indicate that the lattice mismatch is not the main origin of mobility suppression but doped La^{3+} ions were not activated at around the film/substrate interfaces. Thus, we should clarify the origin of La^{3+} inactivation at around the films/substrate interfaces to improve the electron mobility of BLSO films.



FIG| Electron transport properties of the $Ba_{0.98}La_{0.02}SnO_3$ epitaxial films at room temperature; (a) Carrier concentration, *n*, (b) Thermopower, *S*, and (c) Hall mobility, μ_{Hall}. The Hall mobility increases with thickness and saturates at ~100 $cm^2\ V^{-1}\ s^{-1}$.

References

[1] H. J. Kim *et al.*, *Appl. Phys. Express* **5**, 061102 (2012).
[2] W-J. Lee *et al.*, *Appl. Phys. Lett.* **108**, 082105 (2016).