Laドープ $BaSnO_3$ 薄膜の電子移動度抑制の起源(II)

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

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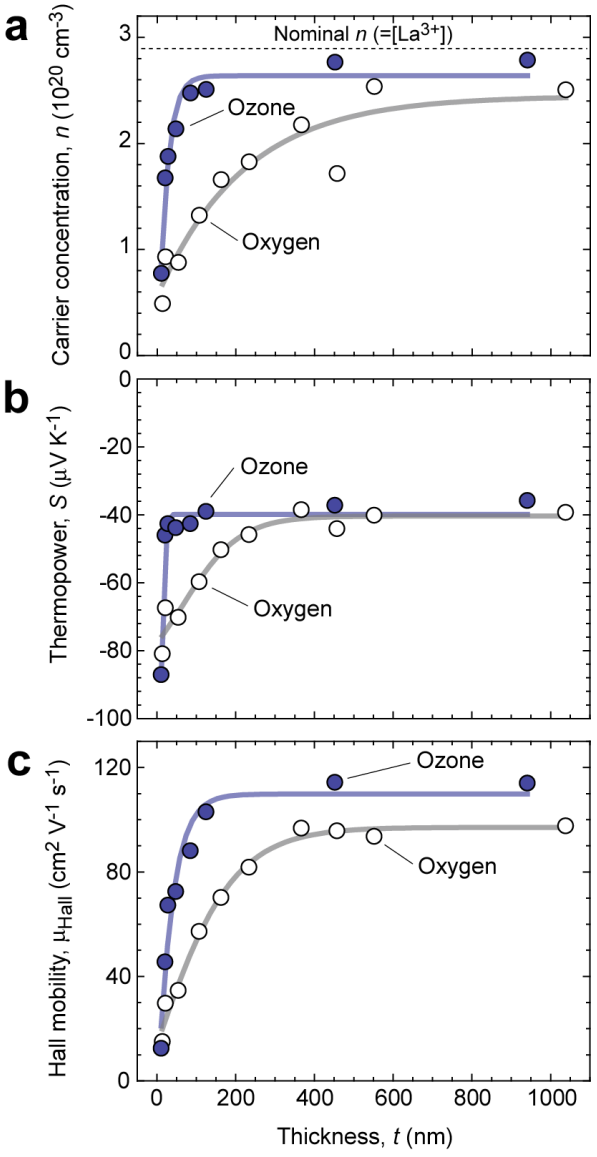
As discussed in the part-I abstract, La-doped $BaSnO_3$ (BLSO, *Pm*-3*m*, *a*=4.115 Å, E_g~3.1 eV) epitaxial films exhibit only ~100 $cm^2\ V^{-1}\ s^{-1}$ though the single crystal exhibit very high mobility of 320 $cm^2\ V^{-1}\ s^{-1}$.[1] The main origin of mobility suppression is considered to that doped La^{3+} ions were not activated at around the film/substrate interfaces. In order to clarify the origin of La^{3+} inactivation, we performed LAADF-STEM observations and EELS analyses (data not shown). We have clarified that oxygen concentration at around the BLSO film and substrate interface is lower than that in the bulk region. We have also detected 2+ valence state of Sn in the BLSO film by XAS. Since Sn^{2+} ions play not only as electron acceptor but also ionized impurity, mobility and carrier concentration suppression occurred simultaneously.

In order to minimize the oxygen deficiency at the heterointerface region, we fabricated BLSO ($Ba_{0.98}La_{0.02}SnO_3$) epitaxial films by PLD under 10% ozone atmosphere. **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. The *n*, *S*, and μ_{Hall} dramatically increase in the thinner region (*t*<100 nm) and saturate ~2.6×10^{20} cm^{-3}, −40 μV K^{-1}, and ~115 $cm^2\ V^{-1}\ s^{-1}$, respectively. Note that the obtained mobility (~115 $cm^2\ V^{-1}\ s^{-1}$) is the highest value among the BLSO films grown by PLD.

Thus, we concluded from these results, oxygen off-stoichiometry at around the interface is the main origin of mobility suppression and the mobility can be improved by the film growth under highly oxidative condition. This conclusion is consistent with the fact that the BLSO films grown by MBE under oxygen plasma exhibited very high mobility.[2]



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}. (closed symbol: grown under ozone (10%) atmosphere, open symbol: oxygen atmosphere) The Hall mobility reaches ~115 $cm^2\ V^{-1}\ s^{-1}$, which is the highest value among the BLSO films grown by PLD.

References

[1] H. J. Kim *et al.*, *APEX* **5**, 061102 (2012).

[2] H. Paik *et al.*, *APL Mater.* **5**, 116107 (2017).