

Electric Field Thermopower Modulation of BaSnO₃ Epitaxial Film

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Recently, electron doped BaSnO₃ (S.G.: *Pm-3m*, Cubic perovskite structure, $a=4.115$ Å, $E_g\sim 3.1$ eV) has attracted growing attention as a transparent oxide semiconductor. Since the conduction band of BaSnO₃ is mainly composed of widely spread Sn 5s orbitals, BaSnO₃ single crystal exhibits very high electron mobility at room temperature (~ 300 cm² V⁻¹ s⁻¹). Although several researchers reported the effective mass to clarify the origin of such high mobility, the values are widely scattered from 0.06 to 0.6 m_0 . Here we report reliable effective mass, which can be clarified by the electric field thermopower modulation of BaSnO₃ epitaxial films. We fabricated three-terminal thin film transistors on BaSnO₃ epitaxial films, which were fabricated on (001) SrTiO₃ single crystal by PLD followed by the thermal annealing at 1200 °C in air. Amorphous C12A7 film (~ 300 nm, $\epsilon_r=12$) was used as the gate insulator. The sheet carrier concentration was modulated from 10^{11} to 10^{13} cm⁻² by applying positive gate voltages. During the gate voltage application, we measured the thermopower of the BaSnO₃ channel simultaneously as shown in Fig. The thermopower was modulated from 310 to 120 μ V K⁻¹, which is ~ 600 μ V K⁻¹ lower than that of SrTiO₃ ($m^*=1.16$ m_0), demonstrating smaller carrier effective mass of BaSnO₃ ($m^* < 0.2$ m_0). Further, we fabricated Nb-doped BaSnO₃ epitaxial films ($n\sim 10^{21}$ cm⁻³) and clarified that the epitaxial films exhibit rather large the effective mass ~ 0.6 m_0 . Since thermopower strongly depends on the energy derivative of the electronic density of states at around the Fermi energy, these results clearly indicate that the energy dependence of the density of states of BaSnO₃ is not simple parabolic in shape; this would be the reason of that the reported effective mass values are widely scattered.

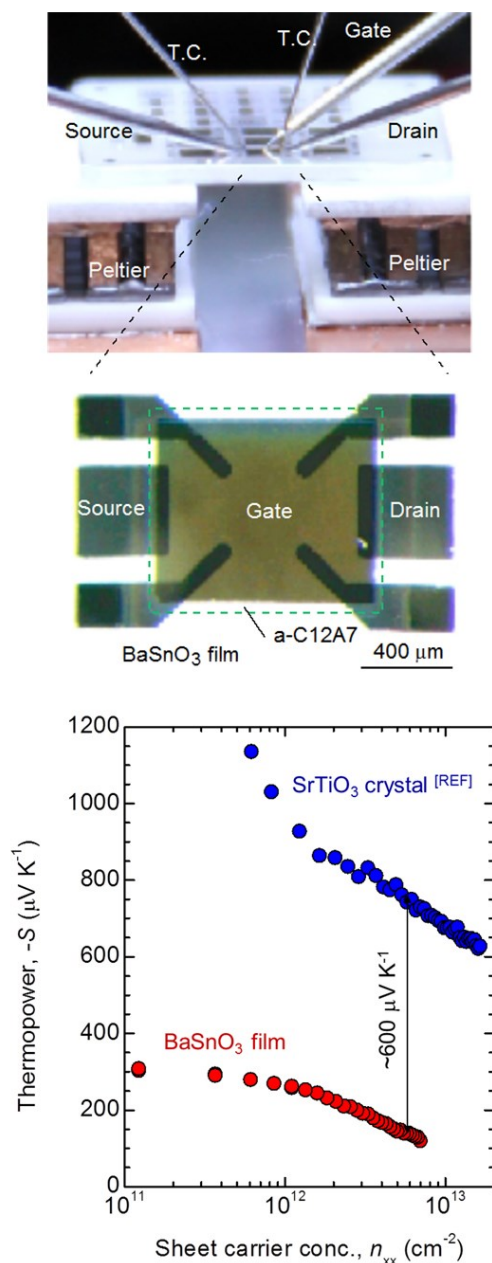


Figure | (upper) Measurement setup of the electric field modulated thermopower. (bottom) Sheet carrier concentration dependence of thermopower for BaSnO₃ epitaxial film. [Ref] H. Ohta *et al.*, *Appl. Phys. Lett.* **95**, 113505 (2009).

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