Gd-Doped BaSnO₃ Thin Films: High Mobility in a Magnetically-Doped Transparent Conducting Oxide

URUSA ALAAN, Stanford University, PADRAIC SHAFER, ALPHA N’DIAYE, ELKE ARENHOLZ, Lawrence Berkeley National Laboratory, YURI SUZUKI, Stanford University — It has recently been shown that when the perovskite-structure BaSnO₃ (BSO) is doped with Laᵦba’, the result is a transparent conducting oxide with room-temperature electron mobilities that are much higher than conventional ternary oxides. The ability to achieve high carrier mobilities in BSO is promising for future perovskite-structure devices. We have used pulsed laser deposition to grow epitaxial thin films of Ba₀.₉₆Gd₀.₀₄SnO₃ (Gd:BSO) and Ba₀.₉₆La₀.₀₄SnO₃ (La:BSO) on (001) SrTiO₃ and (001) MgO substrates. At 300 K, Gd:BSO films have ρ≈2 mΩ·cm, \(\mu_e\approx28 \text{ cm}^2/\text{V}·\text{s}\) and \(n\approx1.0 \times 10^{20} \text{cm}^{-3}\). At the same temperature, La:BSO films have ρ≈0.4 mΩ·cm, \(\mu_e\approx58 \text{ cm}^2/\text{V}·\text{s}\) and \(n\approx2.5 \times 10^{20} \text{ cm}^{-3}\). While La:BSO is diamagnetic, Gd:BSO is paramagnetic with a clear magnetic response that saturates at \(\approx7\mu_B/\text{Gd}^{3+}\), and a negative ordinary magnetoresistance at low temperatures. Like La:BSO, Gd:BSO is transparent and colorless in the visible regime. Thus, we have shown that Gd is good dopant for BSO in order to achieve transparency and metallicity that is coincident with a magnetic response.

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