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Improving Thermoelectric Properties of Bi_2Te_3 Thin Films By Manganese Co-Sputtering

[Journal of Visualized Experiments](#) • Article • 2026 • DOI: 10.3791/71082 Th'ng, Angella ^a ; Musri, Nurfarhana Ahmad ^a; Chelvanathan, Puvaneswaran ^a; Su'ait, Mohd Sukor ^a; Yatim, Nadhrah Md ^b; [+2 authors](#)^a Solar Energy Research Institute, SERI, Universiti Kebangsaan Malaysia, Malaysia[Show all information](#)

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Abstract

Bi_2Te_3 remains a benchmark n-type thermoelectric (TE) material for low-temperature energy conversion, but its small band gap can reduce efficiency because of thermally generated parasitic carriers. Elemental doping has been explored to improve TE performance, although systematic studies on manganese (Mn)-doped Bi_2Te_3 thin films remain limited. In this study, a radiofrequency magnetron co-sputtering workflow was used to fabricate Mn-doped Bi_2Te_3 thin films by varying Mn target power while maintaining constant Bi_2Te_3 deposition conditions. Structural, microstructural, compositional, and TE transport properties were evaluated using X-ray diffraction, field-emission scanning electron microscopy, energy-dispersive X-ray spectroscopy, and temperature-dependent transport measurements. X-ray diffraction confirmed retention of the rhombohedral Bi_2Te_3 phase with a preferred (015) orientation, while peak shifts toward higher 2θ values were consistent with Mn-related lattice contraction. All films exhibited negative Seebeck coefficients, confirming n-type conduction. Increasing Mn doping enhanced the magnitude of the Seebeck coefficient but also increased electrical resistivity, demonstrating a transport tradeoff. The film deposited at 5 W Mn

power achieved the highest power factor of $529.33 \mu\text{W m}^{-1} \text{K}^{-2}$ at 523 K because of its low resistivity combined with adequate thermopower. These results demonstrate that moderate Mn incorporation can improve the power-factor-related performance of Bi_2Te_3 thin films within the measured temperature range. © 2026, Journal of Visualized Experiments Journal of Visualized Experiments.

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