

On-Film Formation of Nanowires for High-efficiency Thermoelectric Devices

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Abstract : We report the invention of a direct growth method termed On-Film Formation of Nanowire (OFF-ON) for making high-quality single-crystal nanowires, i.e. Bi and Bi₂Te₃, without the use of conventional templates, catalysts, or starting materials. We have used the OFF-ON technique to grow single crystal semi-metallic Bi and compound semiconductor Bi₂Te₃ nanowires from sputtered Bi and BiTe films after thermal annealing, respectively. The mechanism for nanowire growth is stress-induced mass flow along grain boundaries in the polycrystalline films. OFF-ON is a simple but powerful method for growing perfect single-crystal semi-metallic and compound semiconductor nanowires of high aspect ratio with high crystallinity that distinguishes it from other competitive growth approaches that have been developed to date. Our results suggest that Bi and Bi₂Te₃ nanowires grown by OFF-ON can be an ideal material system for exploring their unique thermoelectric properties due to their high-quality single crystalline and high conductivity, which have consequence and relevance for high-efficiency thermoelectric devices.

Key Words : Bi, Bi₂Te₃, single-crystal nanowire, stress-induced, thermoelectric