

Thermal Transport in Nanostructured Materials for Heat Management

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Abstract: *Thermal transport in nanostructured materials has become a cornerstone of modern physics and engineering due to the escalating demand for efficient heat dissipation in miniaturized electronic and energy systems. At nanoscale dimensions, classical heat conduction theories fail to accurately describe thermal behavior due to size effects, quantum confinement, and dominant interface scattering. This chapter provides a comprehensive and extended discussion of thermal transport mechanisms in nanostructured materials, focusing on phonon dynamics, ballistic and diffusive transport regimes, and interface phenomena. It also explores advanced materials such as graphene, nanowires, and nanocomposites, along with experimental techniques and emerging applications. The chapter concludes with future research directions and technological challenges..*

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