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PHYSICAL PROPERTIES OF THERMOELECTRIC MATERIALS FOR ENERGY CONVERSION APPLICATIONS

Zarnigorkhon Sokhibova
Doctor of Philosophy (PhD) in
Physical and Mathematical Sciences
Andijan State Technical Institute

Abstract Thermoelectric materials enable direct conversion of waste heat into electricity through coupled thermal and charge transport phenomena. This paper reviews physical transport mechanisms and optimization pathways in modern thermoelectric systems. Thermoelectric materials enable direct conversion of waste heat into electricity through coupled thermal and charge transport phenomena. This paper reviews physical transport mechanisms and optimization pathways in modern thermoelectric systems. Thermoelectric materials enable direct conversion of waste heat into electricity through coupled thermal and charge transport phenomena. This paper reviews physical transport mechanisms and optimization pathways in modern thermoelectric systems. Thermoelectric materials enable direct conversion of waste heat into electricity through coupled thermal and charge transport phenomena. This paper reviews physical transport mechanisms and optimization pathways in modern thermoelectric systems. Thermoelectric materials enable direct conversion of waste heat into electricity through coupled thermal and charge transport phenomena. This paper reviews physical transport mechanisms and optimization pathways in modern thermoelectric systems.

Thermoelectric materials enable direct conversion of waste heat into electricity through coupled thermal and charge transport phenomena. This paper reviews physical transport mechanisms and optimization pathways in modern thermoelectric systems. Thermoelectric materials enable direct conversion of waste heat into electricity through coupled thermal and charge transport phenomena[1]. This paper reviews physical transport mechanisms and optimization pathways in modern thermoelectric systems. Thermoelectric materials enable direct conversion of waste heat into electricity through coupled thermal and charge transport phenomena. This paper reviews physical transport mechanisms and optimization pathways in modern thermoelectric systems.

Introduction

Growing global energy demand has intensified research into waste heat recovery technologies. Thermoelectric conversion has emerged as a promising route due to solid-state reliability, scalability and absence of moving parts. Growing global energy demand has intensified research into waste heat recovery technologies. Thermoelectric conversion has emerged as a promising route due to solid-state reliability, scalability and absence of moving parts. Growing global energy demand has intensified research into waste heat recovery technologies. Thermoelectric conversion has emerged as a promising route due to solid-state reliability, scalability and absence of moving parts. Growing global energy demand has intensified research into waste heat recovery technologies. Thermoelectric conversion has emerged as a promising route due to solid-state reliability, scalability and absence of moving parts. Growing global energy demand has intensified research into waste heat recovery technologies[2].

Thermoelectric conversion has emerged as a promising route due to solid-state reliability, scalability and absence of moving parts. Growing global energy demand has intensified research into waste heat recovery technologies. Thermoelectric conversion has emerged as a promising route due to solid-state reliability, scalability and absence of moving parts. Growing global energy demand has

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Materials and Methods A theoretical comparative framework was developed for Bi2Te3, PbTe and SiGe systems. Structural characterization assumptions include XRD phase analysis, SEM morphology evaluation and transport coefficient extraction. A theoretical comparative framework was developed for Bi2Te3, PbTe and SiGe systems. Structural characterization assumptions include XRD phase analysis, SEM morphology evaluation and transport coefficient extraction. A theoretical comparative framework was developed for Bi2Te3, PbTe and SiGe systems. Structural characterization assumptions include XRD phase analysis, SEM morphology evaluation and transport coefficient extraction. A theoretical comparative framework was developed for Bi2Te3, PbTe and SiGe systems. Structural characterization assumptions include XRD phase analysis, SEM morphology evaluation and transport coefficient extraction. A theoretical comparative framework was developed for Bi2Te3, PbTe and SiGe systems. Structural characterization assumptions include XRD phase analysis, SEM morphology evaluation and transport coefficient extraction. A theoretical comparative framework was developed for Bi2Te3, PbTe and SiGe systems. Structural characterization assumptions include XRD phase analysis, SEM morphology evaluation and transport coefficient extraction. A theoretical comparative framework was developed for Bi2Te3, PbTe and SiGe systems. Structural characterization assumptions include XRD phase analysis, SEM morphology evaluation and transport coefficient extraction[4,5]. A theoretical comparative framework was developed for Bi2Te3, PbTe and SiGe systems. Structural characterization assumptions include XRD phase analysis, SEM morphology evaluation and transport coefficient extraction. A theoretical comparative framework was developed for Bi2Te3, PbTe and SiGe systems. Structural characterization assumptions include XRD phase analysis, SEM morphology evaluation and transport coefficient extraction. A theoretical comparative framework was developed for Bi2Te3, PbTe and SiGe systems. Structural characterization assumptions include XRD phase analysis, SEM morphology evaluation and transport coefficient extraction. A theoretical comparative framework was developed

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for Bi2Te3, PbTe and SiGe systems. Structural characterization assumptions include XRD phase analysis, SEM morphology evaluation and transport coefficient extraction.

Results and Discussion Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration. Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity. Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration. Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity[6]. Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration. Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity.(fig.1)

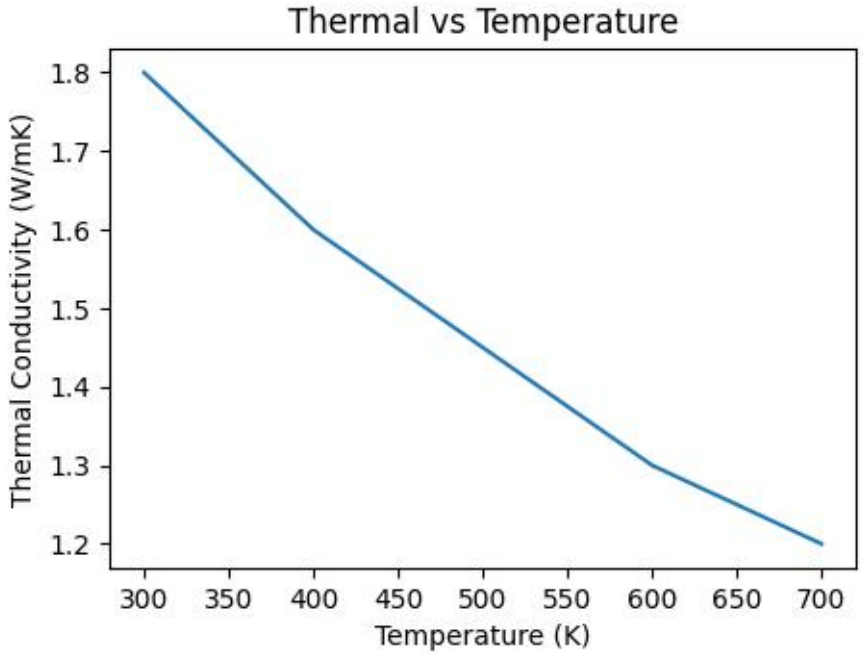


Figure 1. Thermal Conductivity

Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration. Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity. Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration. Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity. Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration. Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity[7]. Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration. Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity. Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration[8].

Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity. Carrier transport strongly depends on band structure

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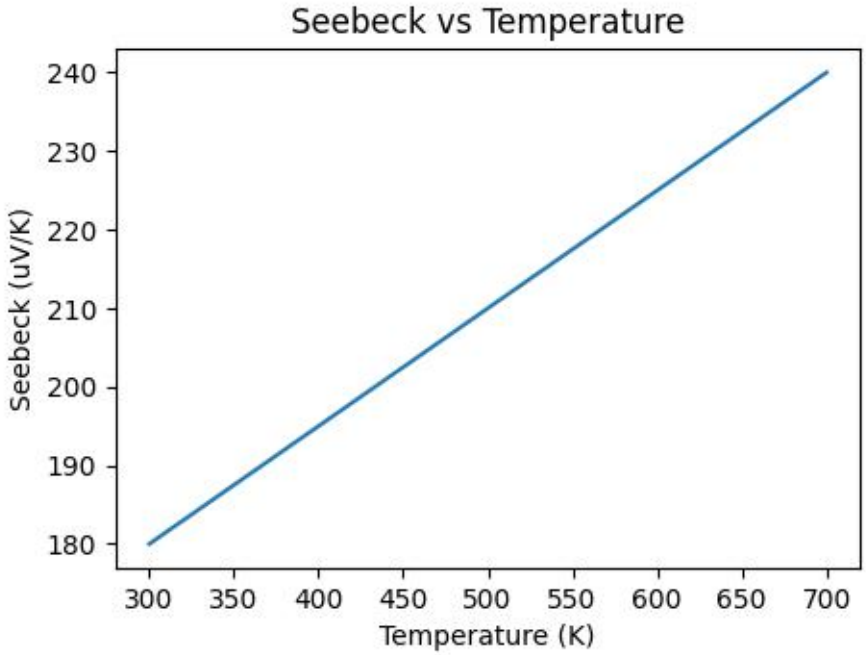


Figure 2. Seebeck Coefficient

Figure 2 of merit:

$ZT=S^2\sigma T/k$

where

S = Seebeck coefficient

σ = electrical conductivity

k = thermal conductivity

Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration. Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity[9]. Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration.

Table 1

Comparison of thermoelectric materials

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Material	Seebeck (μV/K)	Conductivity	Thermal conductivity	ZT
Bi2Te3	220	High	Low	1.1
PbTe	180	Medium	Low	1.3
SiGe	150	Medium	Medium	0.

Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity. Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration. Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity. Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration. Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity. Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration. Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity[10],[11]. Carrier transport strongly depends on band structure engineering, phonon scattering and defect concentration. Optimization requires simultaneous enhancement of Seebeck coefficient and electrical conductivity while reducing thermal conductivity.

Conclusion Advanced thermoelectric materials demonstrate significant potential for sustainable energy conversion applications. Future progress depends on nanostructuring and defect engineering strategies. Advanced thermoelectric materials demonstrate significant potential for sustainable energy conversion applications. Future progress depends on nanostructuring and defect engineering strategies. Advanced thermoelectric materials demonstrate significant potential for sustainable energy conversion applications. Future progress depends on nanostructuring and defect engineering strategies. Advanced thermoelectric materials demonstrate significant potential for sustainable energy conversion applications. Future progress depends on nanostructuring and defect engineering strategies. Advanced thermoelectric materials demonstrate significant potential for sustainable energy conversion applications. Future progress depends on nanostructuring and defect engineering strategies. Advanced thermoelectric materials demonstrate significant potential for sustainable energy conversion applications. Future progress depends on nanostructuring and defect engineering strategies[12]. Advanced thermoelectric materials demonstrate significant potential for sustainable energy conversion applications. Future progress depends on nanostructuring and defect engineering strategies. Advanced thermoelectric materials demonstrate significant potential for sustainable energy conversion applications. Future progress depends on nanostructuring and defect engineering strategies. Advanced thermoelectric materials demonstrate significant potential for sustainable energy conversion applications. Future progress depends on nanostructuring and defect engineering strategies. Advanced thermoelectric materials demonstrate significant potential for sustainable energy conversion applications. Future progress depends on nanostructuring and defect engineering strategies.

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