

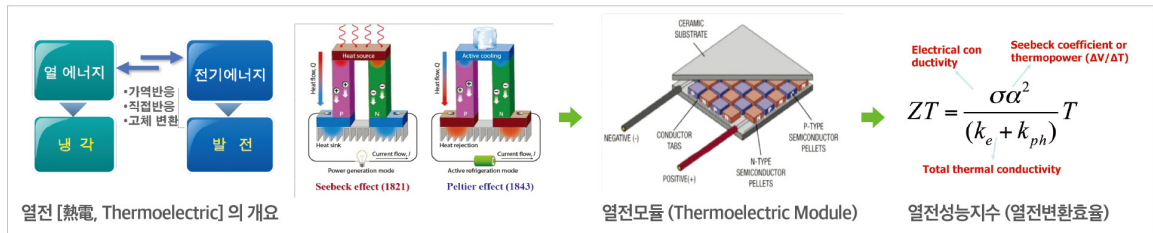
# 열전 에너지변환 나노복합소재 기술

## Nanocomposites for Thermal-to-Electrical Energy Conversion

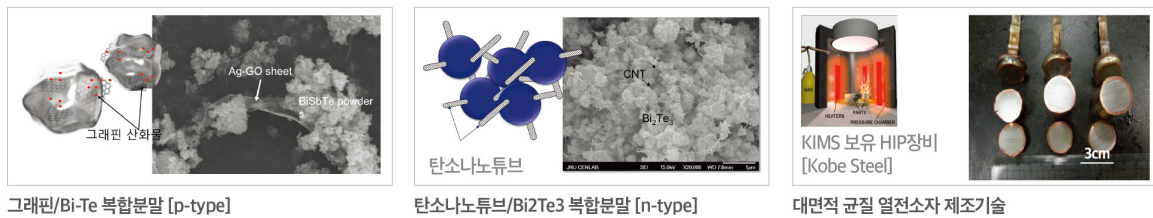
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### 기술내용

- Bi-Te계 상온용 열전변환소재의 성능을 향상시키기 위한 나노복합재료 제조 및 경제적 합성 기술
- 우수한 물성을 갖는 나노소재 (탄소나노튜브, 그래핀, 나노다이아몬드)를 Bi-Te계 소재에 분산시켜 고성능화 달성하는 소재기술

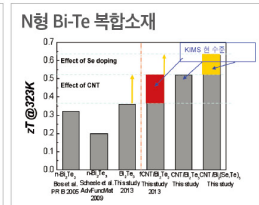


- 응집성 강한 탄소나노튜브, 나노다이아몬드, 그래핀소재를 열전소재내에 분산시킬 수 있는 신공정 개발
- 신공정을 통해 다양한 형태로 응용 가능한 복합분말 원천소재 개발
- 신공정과 원천소재로부터 고성능화 기술 확보 및 고밀도 균질 열전소재 제조기술 개발



### 우수성

- 화학-물리공정을 동시에 사용하여 Bi-Te계 소재내에 탄소나노소재를 성공적으로 분산시키는 기술을 독자 개발함
  - 탄소나노튜브 분산된 Bi-Te계 열전변환소재 합성 [미국특허 1건, 일본특허 1건 및 국내특허 3건 등록]
  - 그래핀소재가 분산된 Bi-Te계 열전변환소재 합성 [국내특허 1건, PCT 1건 확보]
  - Hot Isostatic Pressing공정을 이용한 대면적 열전소재 제작기술 확보
- 재료 가공 손실 최소화 및 최고 성능지수 (ZT) 확보된 열전소재기술 개발
  - 평균 ZT값 1.0 이상 달성



- [특허] KR10-1180263 US8,845,918 JP5214695 열전재료와 이를 원료로 한 복합재료 및 이들의 제조방법

### 사업성

- 현재 대부분 열전변환 소재 및 소자 시장은 냉각분야에 집중되어 있으며 2020년경에는 냉각모듈시장만 최대 60조원의 세계 시장이 기대됨
- 이에 따라 현재 현대자동차, LG전자, LG이노텍, LG화학등의 대기업과 일부 중소기업이 고성능 소재기술 점유에 나서고 있는 실정임

### 활용분야

- 산업 배열 열 활용 발전기[소각로, 제철소등]
- 체열발전기 [모바일 전자소자]
- 와인냉장고등 고부가가치 냉장장치- 전기자동차 등 냉방장치
- 무소음 소형 냉장고
- 능동형 정밀 냉각시스템

### 기대효과



### 이전 가능 기술

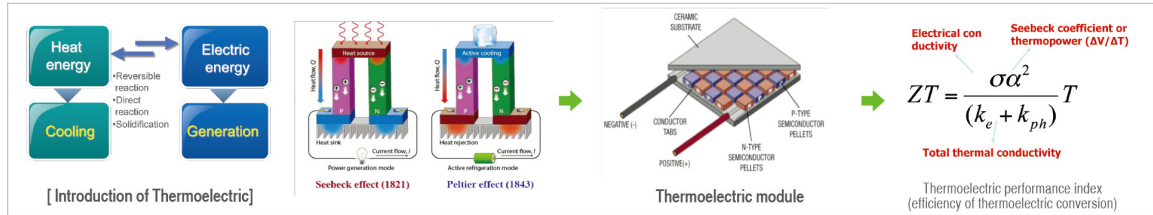
- 독자적인 열전분말소재 고성능화 원천기술
- 열전소재 경제적 제조기술 및 응용기술 (HIP 공정)

# Thermoelectric Nanocomposites

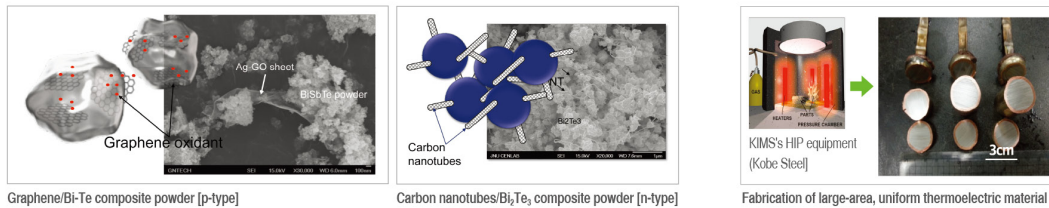
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## Technology Overview

- This technology pertains to fabricating and synthesizing Bi-Te based nanocomposite with high thermoelectric performance (ZT)
- The thermoelectric nanocomposite : nano-materials (i.e. carbon nanotubes (CNTs), graphene, nano-diamond) are homogeneously distributed into Bi-Te matrix materials in order to control carrier and phonon transport properties

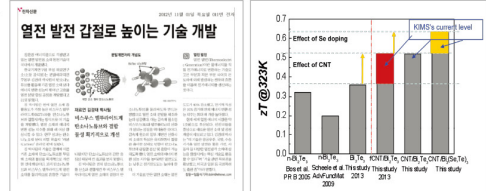


- Development of a new process where carbon nanotubes, nano-diamonds, and graphene materials can be homogeneously distributed into thermoelectric material by chemical and powder metallurgy routes
- Development of thermoelectric composite powders applicable in various forms through the new process [CNT/Bi-Te, Graphene/Bi-Te]
- Enhancement in thermoelectric performance of the newly developed nanocomposites with high density



## Highlights and Strengths

- Proprietary technology to successfully distribute carbon nano material into Bi-Te matrix material by using a combination of chemical and physical processes.
  - Synthesis of Bi-Te base thermoelectric material where carbon nanotubes are distributed [1 patent in U.S., 1 in Japan and 3 in Korea]
  - Synthesis of Bi-Te base thermoelectric material where graphene material is distributed [1 patent in Korea, 1 PCT]
  - Now possible to fabricate large-area thermoelectric elements using hot isostatic pressing method
- Now possible to fabricate thermoelectric elements featuring minimum loss during material processing and highest performance indicators (ZT) possible
  - Average ZT: Over 1.0
- [Patent] KR10-1180263 US8,845,918 JP5214695 A THERMOELECTRIC POWDER AND COMPOSITES MADE FROM THERMOELECTRIC MATERIAL AND METHOD FOR FABRICATING THEREOF



## Business Cases

- Today, most thermoelectric materials and elements are used for cooling. By 2020, the cooling module market alone will be as large as 60 trillion won.
- Currently, large enterprises such as Hyundai Motor, LG Electronics, LG InnoTech and LG Chemical and some SMEs are among those moving first.

### Applicable products and services

- Powder generators using waste heat from industrial sites [incinerators, steel yards]
- Thermoelectric generators [mobile electronic elements]
- Highly valuable coolers such as wine coolers, heaters & air conditioners for electric vehicles
- Noise-free compact fridges
- active precise cooling systems

### Benefits



### Transferable technology

- Technology to synthesize thermoelectric powders which provides high energy-conversion-efficiency
- Technology to fabricate thermoelectric material in a cost-effective manner (HIP process)