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복사열(Radiation heating)을 이용한 고온 열전소재 접촉저항 측정 기술

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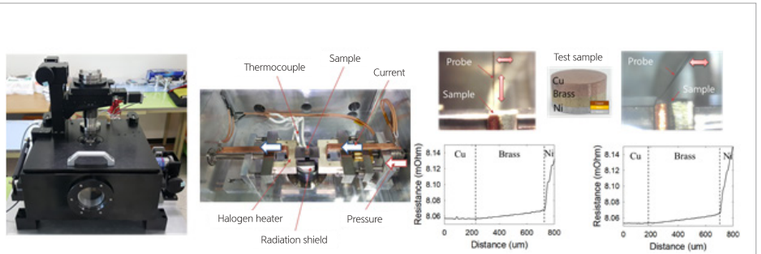
박상현

고온에서 사용하는 열전소재의 접촉저항 측정을 위해 복사열을 이용하여 상온에서부터 열전소재가 동작하는 온도까지 고른 온도분포를 유지하며 접촉저항을 측정하는 기술.

기술의 구성도/개념도

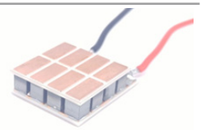


고온접촉저항 측정장비 사진 및 Probing & Scanning 측정기법

기술의 주요 내용 및 특징

- Extrapolation 방식의 측정기법을 도입한 고온 접촉저항 분석 기술
- 할로겐 히터 복사열 가열방식 및 Radiation shield를 통한 열안정 구조
- 최대 측정온도 600℃, 최소 측정간격 5um로 정교한 접촉저항 측정 기술
- Probing과 Scanning모드 측정기법 도입으로 다양한 샘플 측정 가능
- 샘플 압력 Feedback 시스템으로 온도변화에 즉각 대응 가능

기술의 적용처

응용분야	적용제품	
열전 발전 및 냉각	자동차 배기관용 폐열회수 장치, 소각로 등 부착형 발전시스템, 관형 발전시스템, 히트 파이프 부착용 발전장치 등	

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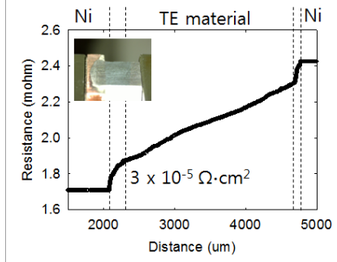
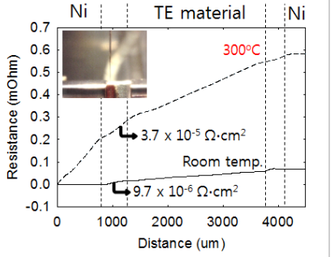
기술의 비교우위성/기존 기술 대비 차별성

기존 기술	본 기술
◦ 상온에서의 Extrapolation 접촉저항 측정 → 열전소재 동작온도에서의 접촉저항 파악 불가 ◦ Probing 모드로 일정간격 저항 측정 → 측정이 느리고 오차가 크게 발생할 수 있음	◦ 고온 Extrapolation 접촉저항 측정 → 열전소재 동작온도에서의 접촉저항을 정확하게 측정 가능 ◦ Probing & Scanning 모드 저항 측정 → 측정이 빠르고 다양한 샘플에 대응 가능한 기술, 적은 오차로 측정가능 ◦ 고온에서의 Noise 최소화 → Radiation shield 구조 개발로 온도 평형을 이루어 Noise 최소화

실험 및 실증 데이터



기존 상온 측정 데이터



고온 접촉저항 장비 측정결과

접촉저항	상온	100°C	200°C	300°C
기존 장비	3 x 10^{-5}			
고온 장비	9.7 x 10^{-6}	1.1 x 10^{-5}	3.1 x 10^{-5}	3.7 x 10^{-5}

»» 고온 접촉저항 측정데이터 확보로 실제 열전소재 동작온도에서의 접촉저항 분석 10-6 Ωcm^2 수준의 낮은 접촉저항 측정가능

기술의 성숙도

[TRL 4: 실험실 규모의 소재/부품/시스템 핵심성능 평가]

Lab scale 시작품 개발 단계

- 고효율화 기술개발 진행
- 양산모사 공정기술 확보 추진 중

지식재산권 현황

순번	발명의 명칭	출원번호	출원일자	등록번호	등록일자
1	열전 소자의 접촉 저항 측정 모듈 및 이를 포함하는 측정 장치	10-2015-0040811	2015.03.24	10-1657986	2016.09.21

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High-temperature thermoelectric material contact resistance measurement technology using radiation heating

The present technology is for measuring the contact resistance of a high-temperature thermoelectric material by maintaining thorough radiation heating a uniform temperature distribution from room temperature to the operation temperature of a thermoelectric material.

Principal researcher

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Structural Diagram/Conceptual Diagram

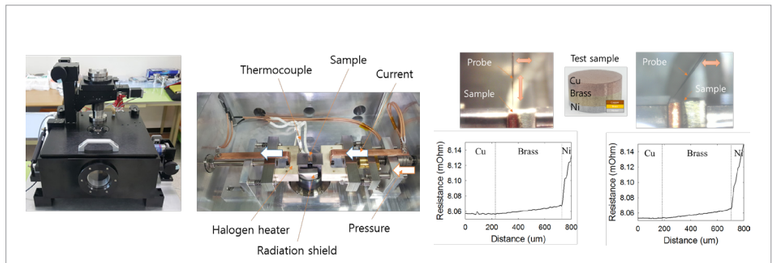
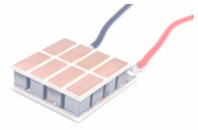


Photo of high-temperature contact resistance measurement equipment and probing & scanning measurement technology

Description and Characteristics of Technology

- A high-temperature contact resistance analysis technology with extrapolation-based measurement technique
- A thermally stable structure based on halogen heater radiation heating and radiation shield
- A precise contact resistance measurement technology available at the highest measurement temperature of 600℃ and the minimum measurement interval of 5 um
- Probing and scanning measurement modes allowing for measurement of various samples
- A sample pressure feedback system allowing for immediate reaction to temperature change

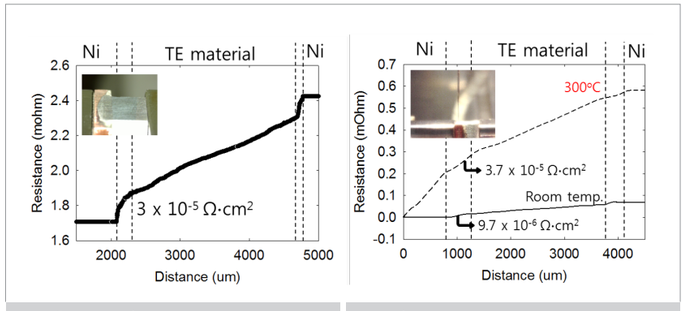
Scope of Application

Application Fields	Products	
Thermoelectric power generation and cooling	Waste heat recovery device for vehicle exhaust, attached type power generation system such as incinerator, pipe-type power generation system, heat pipe attached power generation apparatus, etc.	

Comparative advantages of technology / Differentiation from existing technologies

Conventional Technology	Present Technology
◦ In the conventional technology the extrapolation contact resistance is measured at room temperature. → Impossible to measure the contact resistance at the operating temperature of a thermoelectric material ◦ Constant interval resistance measurement in probing mode → Slow measurement and large errors	◦ The present technology allows measurement of the extrapolation contact resistance at a high temperature. → The contact resistance at the operating temperature of a thermoelectric material may be accurately measured. ◦ The present technology allows measurement of the resistance in the probing & scanning modes. → Rapid measurement; applicable to various samples; small errors ◦ Noise minimized at a high temperature → Radiation shield structure minimizes the noise by providing temperature equilibrium.

Experimental and empirical data



Conventional Measurement Equipment | High-temperature Measurement Equipment

Contact resistance equipment	Room temperature	100℃	200℃	300℃
Conventional	30 μΩ·cm^2	-	-	-
For high temperature	9.7 μΩ·cm^2	11 μΩ·cm^2	31 μΩ·cm^2	37 μΩ·cm^2

››› As the high-temperature contact resistance measurement data are secured, the contact resistance at the actual operating temperature of a thermoelectric material may be analyzed precisely at the level of 10-6 Ωcm^2.

Maturity level of technology

1 2 3 **4** 5 6 7 8 9

Basic Research | Experiment | Prototype | Turning into practice | Commercialization

[TRL 4: Lab-scale core performance evaluation of materials, parts, and system]

Lab scale prototype development level

- R&D work to increase the efficiency of the technology is now being carried out.
- R&D work to secure the process technology for manufacturing simulation is now being carried out.

Current status of intellectual property rights

No.	Title of Invention	Application Number	Application Date	Registration Number	Registration Date
1	Contact resistance measuring module of thermal device and measuring apparatus having the same	10-2015-0040811	2015.03.24	10-1657986	2016.09.21