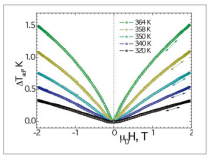
온도조절용 고효율 자기냉매 제조기술

Synthesis of magnetic refrigerants for temperature control

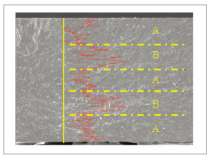
TRL2

기술내용

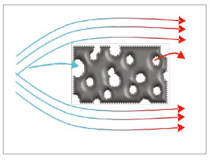
- 자기열량효과를 이용한 자기냉각기의 성능과 효율, 작동온도는 사용되는 자기냉매에 크게 의존
- 자기냉각기의 상용화를 견인하기 위해 넓은 작동범위에서 우수한 냉각능력과 열효율 특성의 자기냉매 필요
- 자기냉매를 고효율화하고 넓은 작동온도를 갖는 다층형 자기냉매 개발
- 열효율 기능이 향상된 자기냉각기 맞춤형 복잡형상 자기냉매 제조기술 및 소결기술 개발



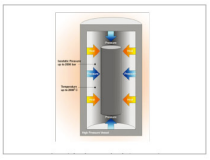
고효율 자기냉매 개발



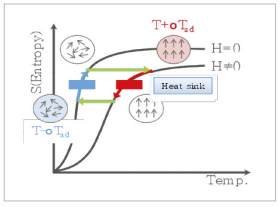
Cascade구조 통한 작동온도 다변화



복잡형상화 통한 자기냉각기 열전달 효율 극대화



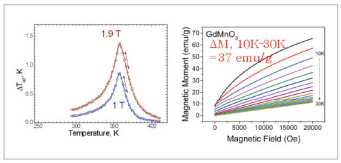
나노분말 소결기술 통한 자기냉매 활용성 증대



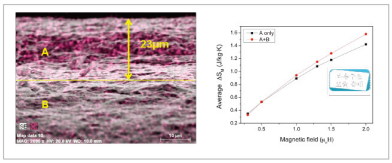
자기열량 효과 개념도

- 소비자가 원하는 온도에서 최대의 냉각능력을 발휘하기 위해서는 1) 우수한 자기냉매, 2) 자기냉각기 작동온도에서 특성 최적화, 3) 열전달 특성 극대화를 통한 자기냉각기의 에너지효율 향상이 유기적으로 이루어 져야 함

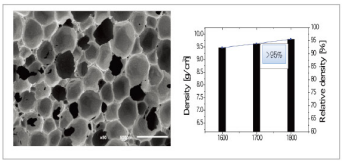
- 상온에서 극저온까지 아우르는 자기냉매
  - 상온용 산화물 소재: 고온안정성 우수
  - 저온용 산화물 소재: 제조 및 취급용이



- 넓은 작동온도 위한 다층형 자기냉매 제조기술
  - GSV를 이용한 마이크론 단위 다층구조
  - Tape casting을 이용한 다층 cascades structure



- 자기냉매 활용기술
  - 열용량/열교환 특성제어 자기냉매
  - 분말상 자기냉매 소결통한 활용성제고



우수성

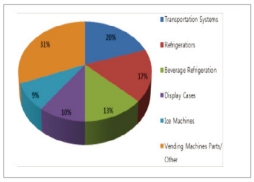
- 자기냉각기 실사용을 염두에 둔 폭넓은 온도영역대에서 활용가능한 산화물/비산화물 자기냉매 합성 기술 개발
- 자기냉매의 조성, 미세구조, 형상, 구조 등을 통한 맞춤형 자기냉매 제어기술 개발 및 특성평가 기술 보유
- 대형 냉난방장비에서 소형 active cooling device까지 적용가능한 요소기반기술 확보

- **[특허] KR10-2017-0090742 자기냉각기용 다층 자기냉매 제조방법**

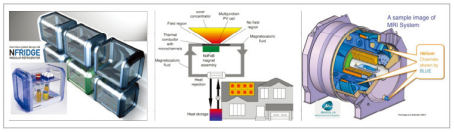
사업성

- 각종 환경규제에 따른 CO2 감소 요구에 부응하는 친환경 냉방기술의 필요성 대두
- 자기냉각 기술은 독성냉매를 사용하지 않고 높은 에너지 효율을 보이는 친환경 기술임
- 미국의 경우 상업용 냉동기 시장은 매년 4.6% 성장, 2016년 940억 달러 규모이고 향후 자기냉동기가 서서히 입지를 넓힐 것으로 예상
- 원하는 온도에서 고효율 특성을 갖는 맞춤형 자기냉매 제조기술은 매우 시기적절한 기술임

미국내 유형별 냉동기시장 수요현황
출처: Freedonia group 발행



기대효과



- 몬트리올 의정서에 의거 기존 냉동기의 독성냉매가 사용 중지됨에 따라 변화하는 세계 냉동기 시장에 유연하게 대처하는 기반기술

활용분야

- 소형냉동기
- 와인냉장고
- 모바일 아이스박스
- 자동차 쿨시트
- IT 기기 쿨러
- 군수분야 : 레이더, 전자기 레일건, 고속 전투기 디스플레이, 전차장용 냉동기 등

이전 가능 기술

- 자기냉매 합성 및 맞춤형 복잡형상 제조기술
- 나노분말 소결기술

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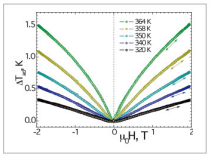
Synthesis of Magnetic Refrigerants for Temperature Control

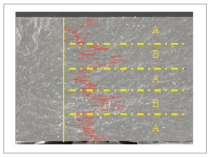
TRL2

Technology Overview

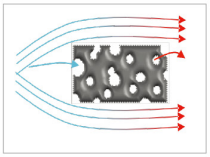
- The performance, efficiency and operating temperature of magnetic cooler using magnetocaloric effect depends on the magnetic refrigerant used.
- To help commercialize magnetic coolers sooner, magnetic refrigerant having better cooling capacity and thermal efficiency in broad operating range is required.
- KIMS has developed multi-layered magnetic refrigerants those are highly efficient and operable at broad operating temperatures.
- Synthesis and sintering technology of complex-geometry-magnetic refrigerants customizable to various magnetic coolers has been also developed.



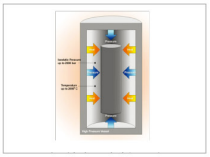
High efficient magnetic refrigerants



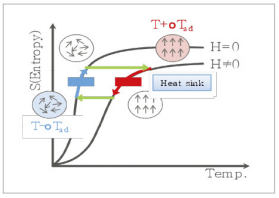
Broaden operating temperature through cascade structure



Maximized thermal conductivity via complex geometry of magnetic refrigerants



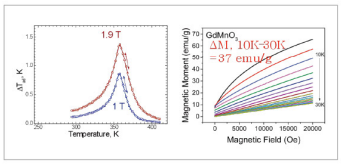
Higher utility of magnetic refrigerant throughnano powder sintering

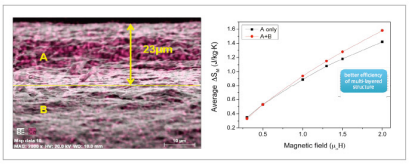


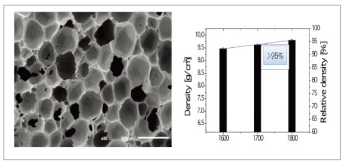
Magnetocaloric effect: concept

- To achieve the highest cooling performance at a customer preferred temperature, the magnetic cooler should improve its energy efficiency by combination of 1) good magnetic refrigerants, 2) property optimization at the operating temperature and 3) maximization of thermal conductivity.

- Magnetic refrigerants covering room temperature to ultra low temperature
  - Oxide refrigerants for room temperature: Good high temperature stability, for low temperature usage: Easy to fabricate and handle in comparison with non-oxide ones
- Technology to fabricate multi-layered magnetic refrigerants for broad operating temperature
  - Micro-level multi-layered structure using GSV
  - Multi-layered cascade structure using tape casting process
- Applications for magnetic refrigerants
  - Magnetic refrigerants to control properties of heat capacity and exchange
  - Higher utility through sintering of powder phase magnetic refrigerants







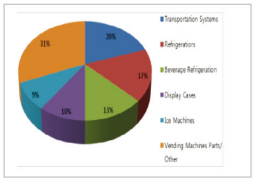
Highlights and Strengths

- Now possible to synthesize oxide/non-oxide magnetic refrigerants to be utilized over a broad temperature range
- Now possible to make customizable magnetic refrigerants in terms of composition, microstructure, geometry, structure, etc.
- Fundamental technology applicable to large air-conditioners/heaters to small active cooling devices

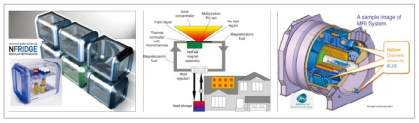
- **[Patent] KR10-2017-0090742 METHOD OF MANUFACTURING MAGNETIC REFRIGERANT FOR MAGNETIC REFRIGERATION**

Business Cases

- Emerging need for eco-friendly cooling technologies in line with demand for less CO_2 emissions
- Magnetic cooling does not require toxic refrigerant and has good energy efficiency.
- In the U.S., the marke t for commercial cooling devices has been growing by 4.6 percent annually, reaching $94 billion in 2016. The market share of magnetic coolers will be expanded.
- The technology to fabricate magnetic refrigerant having high efficiency at preferred temperatures is highly well-timed request.



Demand for cooling devices by type in US
(Source: Freedonia Group)



- With toxic refrigerants no longer allowed under the Montreal Protocol, this technology can provide good alternatives in the global cooling device market.

Applicable products/services

- Small freezers
- Wine coolers
- Mobile ice boxes
- Ventilated seats for cars
- IT device coolers
- Military: Radar, electromagnetic rail guns, fighter jet displays, air conditioners for tanks

Transferable technology

- Technology to synthesize magnetic refrigerants and customized complex eometry
- Technology to sinter nano powder

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