Magnetocaloric alloys for active magnetic regenerative refrigeration

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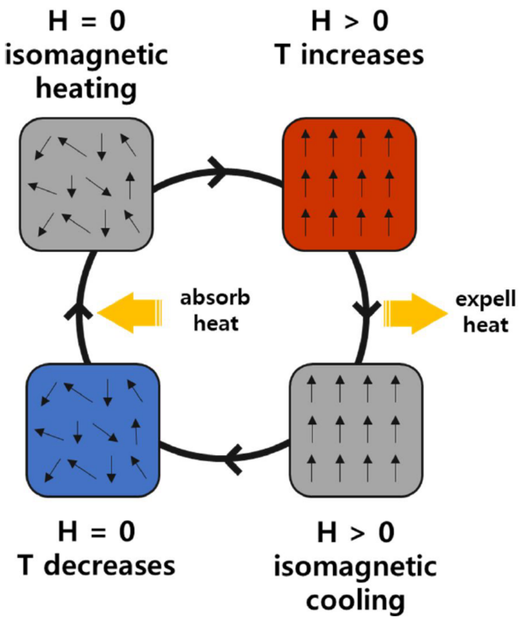
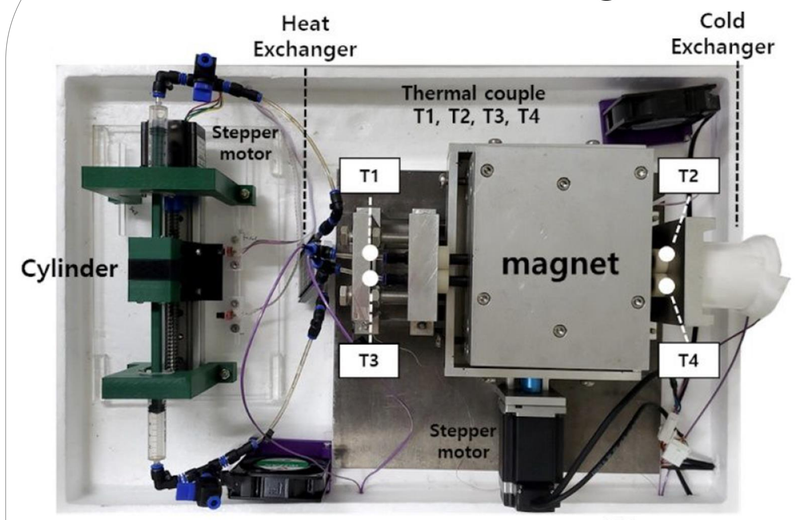
The study explored $Mn_xFe_{5-x}Si_3$ alloys (x = 1, 1.1, 1.2, 1.3) for potential use in room temperature refrigeration through active magnetic regenerators (AMRs). By adjusting the Mn content, the Curie temperature (T_C) and operational range of these magnetic refrigerants were customized. However, the peak magnetic entropy change, and maximum adiabatic temperature change decreased as the Mn substitution increased. Testing with $Mn_{1.2}Fe_{3.8}Si_3$ in an in-house AMR setup achieved a 4.75 K temperature span at 300 K between its cold and hot ends, compared to 7.5 K for Gd. Despite lower magnetic performance compared to Gd, $Mn_xFe_{5-x}Si_3$ alloys are attractive due to their lower cost and better processability.

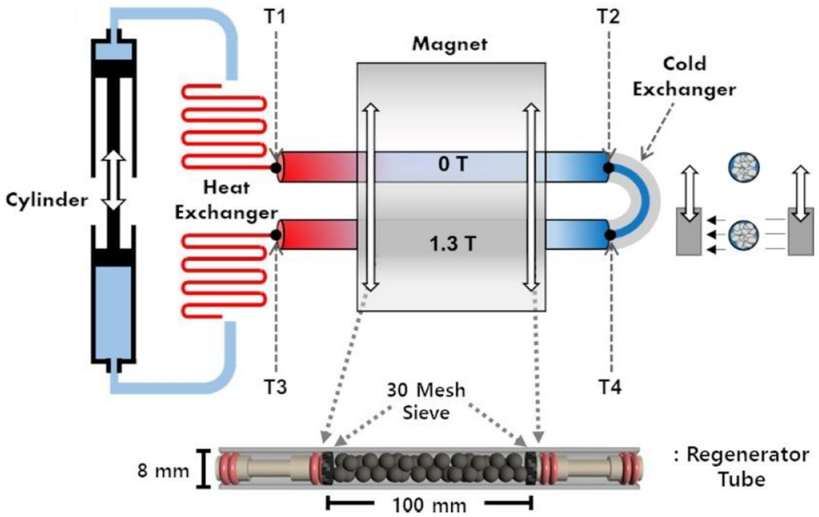
Magnetocaloric effect



Schematic diagram of magneto-thermodynamic cycle

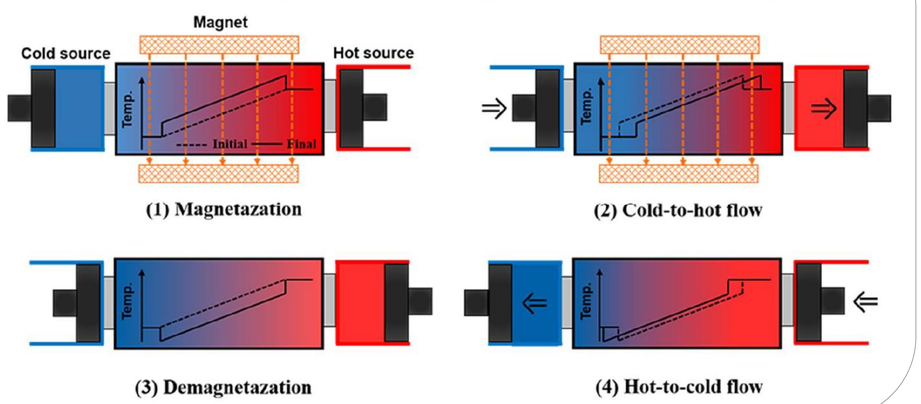
Active magnetic regenerative refrigeration



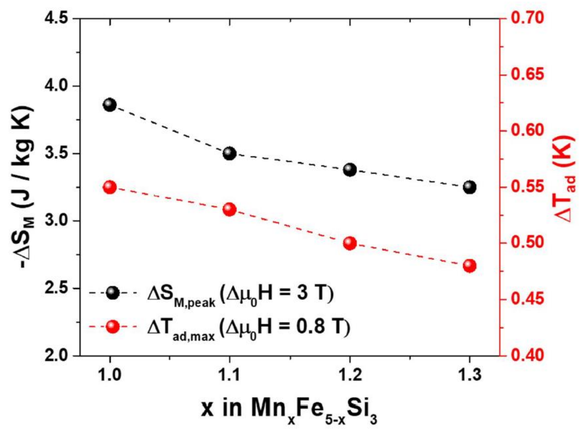


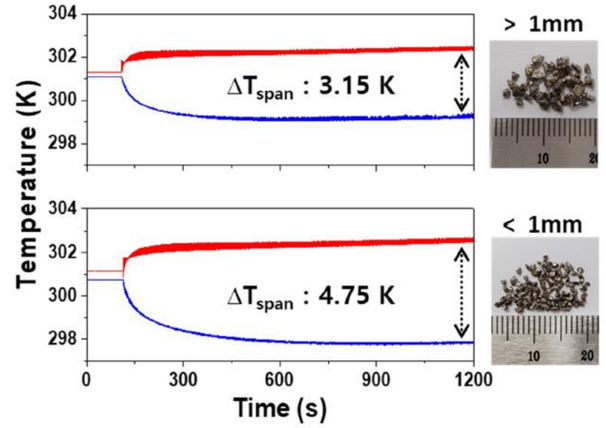
(left) AMR testbed built in-house consists of a linear-type magnet in Halbach array with a maximum field of 1.3 T, dual syringe pumps, carbon fiber tubes packed with refrigerant, and two hot-side heat exchangers (right) Schematic diagram of the AMR system based with dual refrigerant beds for efficient cooling and the refrigerant tube in which the magnetocaloric material is packed

Active magnetic regeneration cycle



Cooling performance of $Mn_xFe_{5-x}Si_3$





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