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Supplementary Information

On the magnetocaloric effect in biphasic FeCrSiB amorphous composites

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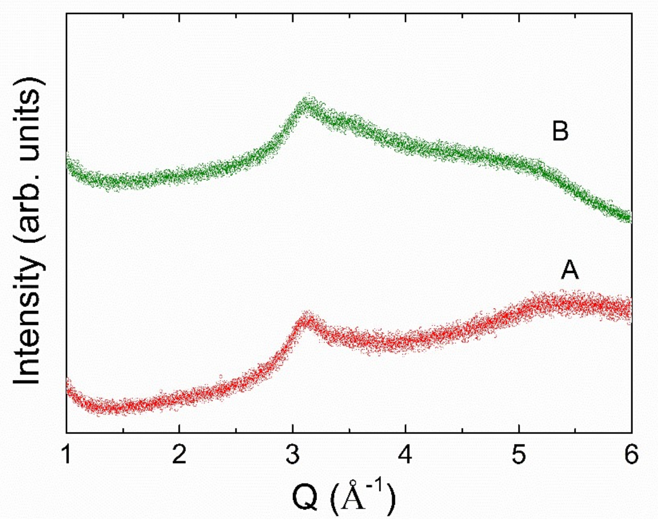

Fig. S1 Room-temperature X-ray diffraction patterns of ribbons A (lower pattern, red points) and B (upper pattern, green points). The patterns are shifted vertically for clarity. The broad humps centered above Q = 3.2 and 6.5 Å^{-1} confirm the amorphous nature of both samples. The absence of sharp crystalline reflections indicates a fully amorphous structure.

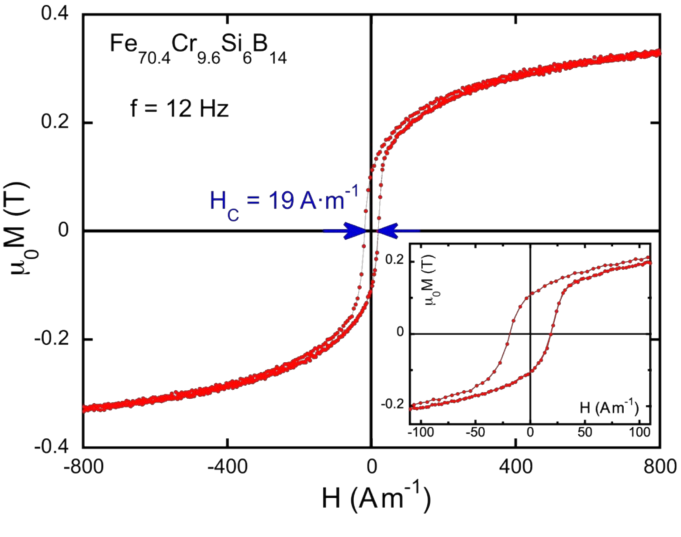

Fig. S2 Room-temperature magnetic hysteresis loop ($\mu_0 M$ vs H) for ribbon A measured under quasi-static conditions. The main panel displays the full loop, confirming ferromagnetic order with a remanence of 0.19 T. The inset shows a magnified view of the low-field region from which a coercive field H_c = 19 A·m^{-1} is determined. The narrow loop width and low coercivity are characteristic of soft magnetic materials.

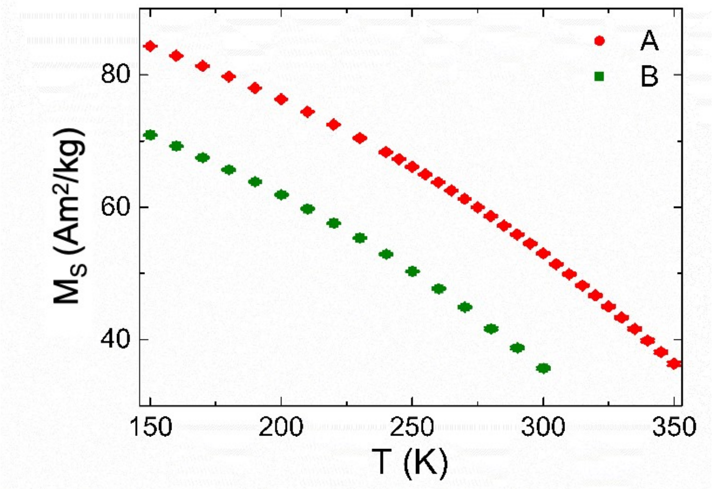

Fig. S3 Saturation magnetization (M_S) as a function of the temperature for ribbons A (red symbols) and B (green symbols) estimated from an approach-to-saturation law from $M(\mu_0 H)$ curves under an applied magnetic field up to $\mu_0 H$ = 8 T. Both curves exhibit a monotonic decrease of M_S with increasing temperature, typical of a second-order magnetic phase transition.

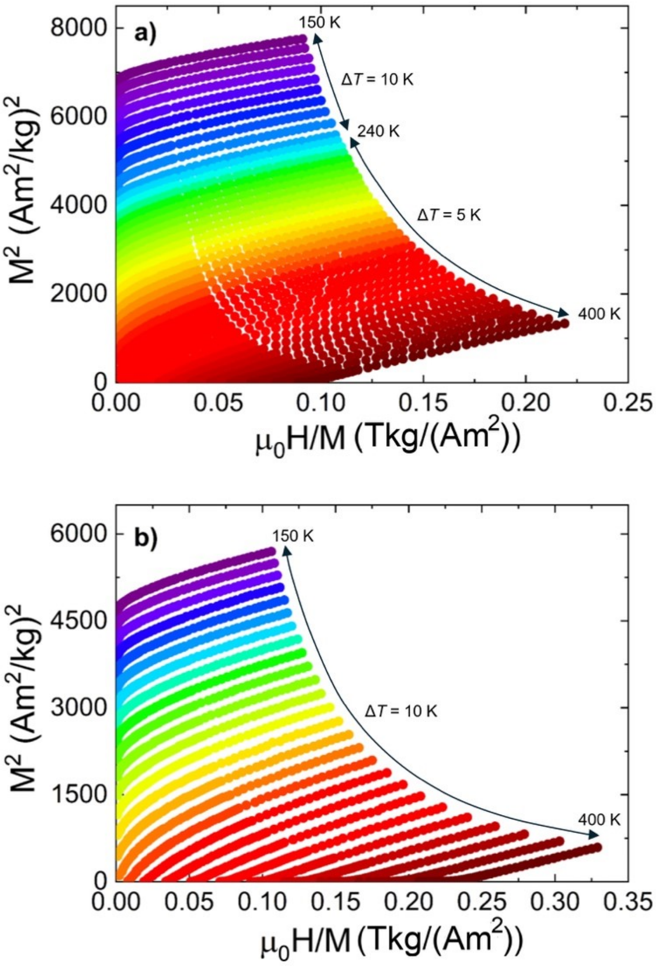

Fig. S4 Standard Arrott plots (M^2 vs $\mu_0 H/M$) constructed from isothermal magnetization curves $M(H)$ measured within the temperature range from 150 K to 400 K in steps of 5 or 10 K for ribbons a) A and b) B. The positive slope of all curves confirms the second-order nature of the magnetic phase transition. The linear extrapolation of the high-field region allows the determination of the spontaneous magnetization and the inverse initial susceptibility.

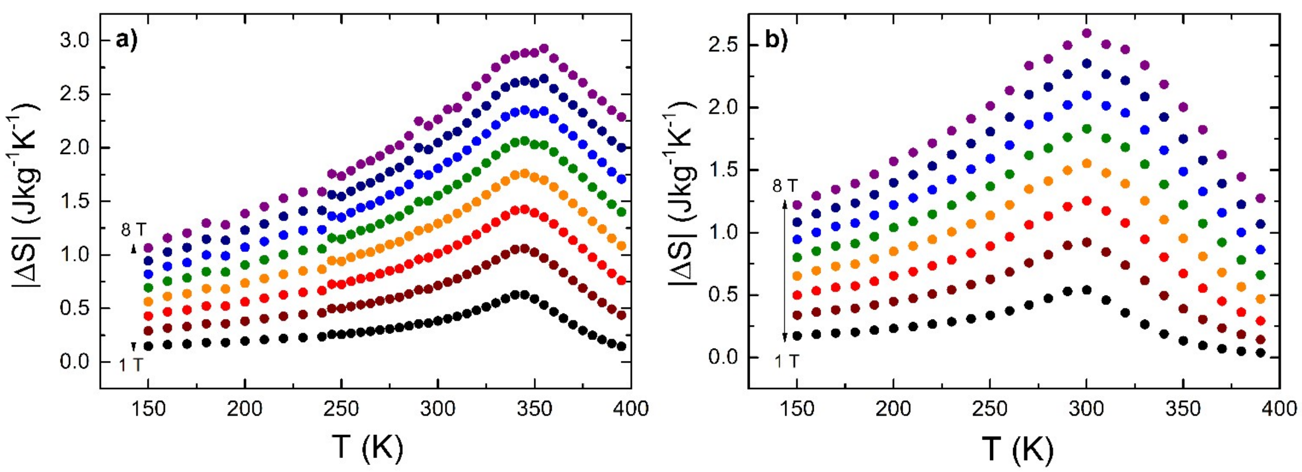

Fig. S5 Temperature dependence of the isothermal magnetic entropy change ($|\Delta S|$) for a) ribbon A and b) ribbon B, derived from isothermal $M(\mu_0H)$ data for magnetic field changes from 1 up to 8 T in steps of 1 T. The maximum entropy change occurs near the respective values of the Curie temperature (T_C = 340 and 290 K for ribbons A and B, respectively). The entropy peak height increases with the value of the magnetic field change, while the broad shape of the curves confirms the second-order nature of the transition. These data are used to design a composite with a table-like magnetocaloric response (see main text).

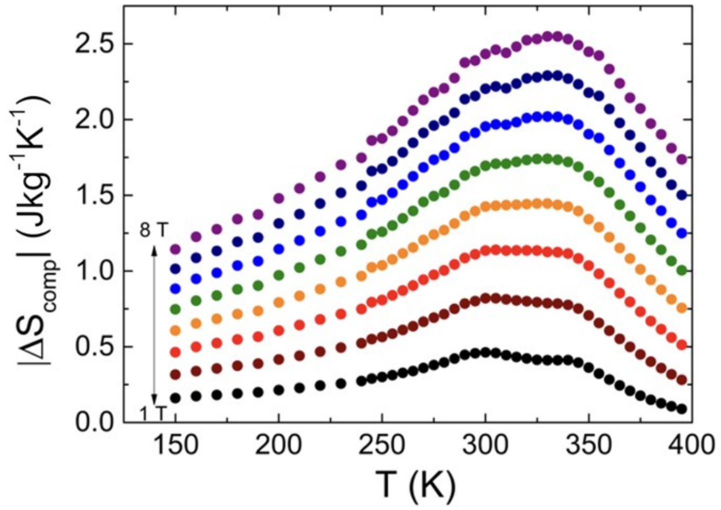

Fig. S6 Temperature dependence of the isothermal magnetic entropy change for the composite ($|\Delta S_{comp}|$) with α = 0.5 (equal weight mixture of ribbons A and B) measured under applied magnetic field changes from 1 up to 8 T in steps of 1 T. The composite exhibits a broad table-like plateau over approximately 50 K, ranging from about 290 K to 340 K, which corresponds to the Curie temperature of the two precursor alloys. This "plateau-like" behavior confirms the successful design of a composite magnetocaloric material with a nearly constant entropy change over a wide temperature span.

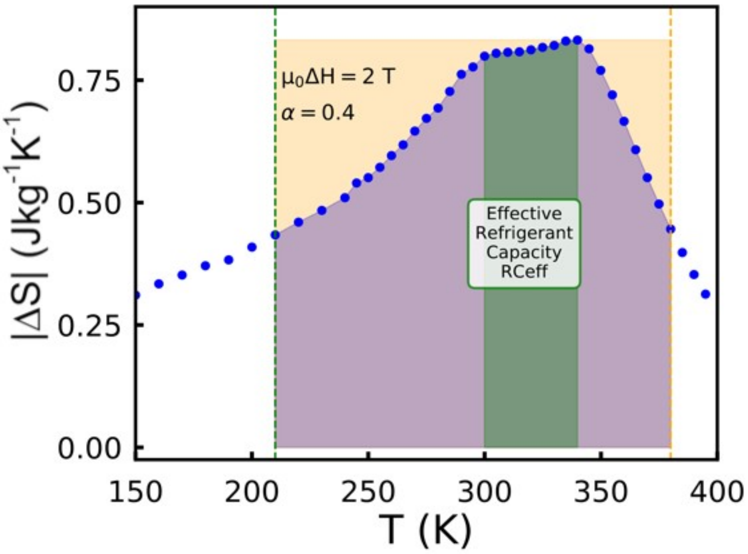

Fig. S7 Temperature dependence of the isothermal magnetic entropy change for the composite ($|\Delta S_{\mathrm{comp}}|$) for the optimized weight-fraction α = 0.4 under $\mu_0\Delta H$ = 2 T. The green shaded area denotes the effective refrigerant capacity, while the orange and purple areas represent RC-1 and RC-2, respectively. The dashed vertical lines mark the cold T_{cold} (green) and hot T_{hot} (orange) operating temperatures. The broad plateau in $|\Delta S_{\mathrm{comp}}|$ highlights the effectiveness of the composite design in delivering a table-like magnetocaloric response (see text for more details).

Experimental methods

Magnetic hysteresis loops were measured by the induction method using an alternating magnetic-field with frequency of 12 Hz.

Numerical calculations

The uncertainty of the magnetic entropy change was estimated to be ~20 %, in accordance with Ref. S1. Uncertainty propagation for *TEC* was performed using a Monte Carlo approach. Specifically, the $\Delta S_{\mathrm{comp}}(T)$ dataset was perturbed using Gaussian noise within the assigned uncertainty at each point. For each perturbed dataset, *TEC* were recalculated following the same numerical procedure (interpolation and integration). This process was repeated at least ~200 times. The final values were then obtained as the average of the resulting distribution, while the associated uncertainty was taken as the corresponding standard deviation.

References:

[S1] V. K. Pecharsky and K. A. Gschneidner, *J. Appl. Phys.*, 1999, **86**, 565.