Magnetocaloric properties of $Ho_{1-x}Dy_xB_2$ alloys.

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The magnetocaloric effect (MCE) is a promising path for the development of refrigeration devices, based on solid-state technology, being an alternative to the conventional gas-based ones [1]. This effect is mainly characterized by two quantities: the magnetic entropy change (ΔS_M) a material will experience when a field change (ΔH) is applied isothermally, or the adiabatic temperature change (ΔT_{ad}) when the field is applied adiabatically. The magnitude of these quantities tends to peak at the spontaneous magnetic ordering temperature (T_{mag}) of a material, such as Curie (T_C) or Néel (T_N) temperature, and its maximum value given an applied ΔH strongly depends on the material. One promising application of this technology is the use for liquefaction of hydrogen, as current MCE-based prototypes, were shown to have an efficiency of approximately 50% (opposed to the usual 25% in Joule-Thomson based ones) [1]. For this, materials that exhibit remarkably high magnetocaloric effect in the temperature range of 20.3 K (LH_2) and 77 K (LN_2) are necessary.

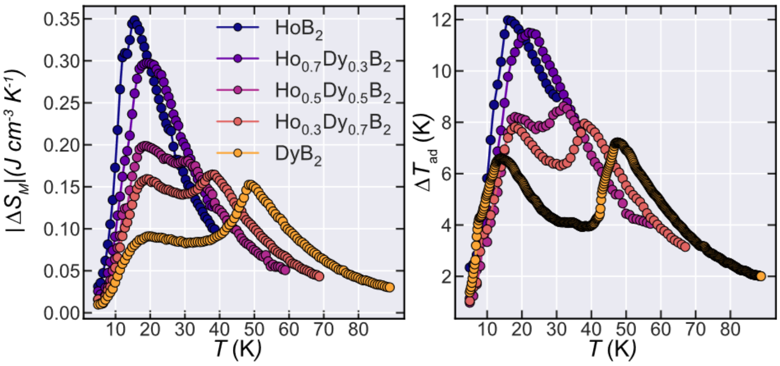

Figure 1 Magnetocaloric properties of $Ho_{1-x}Dy_xB_2$ alloys.

Our group's recent discovery of a gigantic magnetocaloric effect in HoB_2 (T_C = 15 K) [2] with $\Delta S_M = 0.35$ J cm^{-3} K^{-1} and ΔT_{ad} = 12 K for ΔH = 5 T, the highest MCE reported to the best of our knowledge close to LH_2 liquefaction temperature, is a promising material for use in the liquifying stage. However, such a remarkable effect is not desired only close to the liquefaction point, but in all cryogenic temperature range (< 77K). Thus, to tune T_C of HoB_2 we study the effect of Dy substitution in the MCE and magnetic properties of HoB_2, leading to a steady increase of T_C with a reduction in maximum ΔS_M and ΔT_{ad} [3].

In this talk, we will discuss the choice of Dy as a RE for substituting into HoB_2, the effects of such substitution such as crystal structure, magnetic ordering, and MCE properties change. We will also discuss the evolution of the proposed figure of merits, such as the Temperature averaged Entropy Curve (TEC) [4], and still the open challenges that need to be addressed.

References:

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