

Magnetocaloric Effect in a Frustrated Triangular-Lattice Co(II) Coordination System

Dominik Czernia¹ and Gaja Wota¹

¹*Jagiellonian University, Faculty of Chemistry, Gronostajowa 2, 30-087 Kraków*

Magnetically frustrated systems have attracted considerable attention as promising candidates for enhanced magnetocaloric performance, particularly at low temperatures. Large values of the isothermal entropy change have been reported in a variety of geometrically frustrated magnets, including triangular, kagome, and pyrochlore lattices. This behavior originates from the presence of highly degenerate ground states in zero magnetic field, in contrast to the typically non-degenerate ground state of conventional magnetic refrigerants.

In this work, we investigate the magnetocaloric properties of the triangular-lattice cobalt-based magnet $\text{K}_2\text{Co}(\text{HPO}_4)(\text{C}_2\text{O}_4)(\text{H}_2\text{O}) \cdot \text{H}_2\text{O}$, with particular emphasis on the role of magnetic frustration and effective spin reduction in governing the magnetic entropy change. Owing to strong spin-orbit coupling and crystal-field effects, the Co(II) centers can be described by an effective total angular momentum, $J_{\text{eff}} = 1/2$, at low temperatures. This effective spin-1/2 character, when combined with geometric frustration, suppresses long-range magnetic order and stabilizes a dense manifold of low-energy spin states, which is favorable for magnetocaloric cooling.

The magnetic entropy change was derived from isothermal magnetization measurements using the Maxwell relation. For an applied magnetic field of 4 T, the maximum entropy change reaches approximately $14 \text{ J kg}^{-1} \text{ K}^{-1}$ at 2.5 K. To further evaluate the relevance of this compound for magnetic refrigeration, magnetocaloric performance metrics, such as relative cooling power (RCP) or temperature-averaged entropy change (TEC) are employed, providing a more realistic and application-relevant assessment of the cooling capability over a finite operating temperature window.

Finally, a comparison with other Co-based magnetocaloric materials, including unfrustrated and weakly frustrated systems, is presented to elucidate the role of magnetic frustration in enhancing both the magnitude and temperature span of the magnetocaloric effect. Our results support the general concept that geometrically frustrated magnets with effective low-spin ground states constitute a fertile platform for the design of efficient magnetic refrigerants, particularly for low-temperature applications.

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