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A ¹⁶¹Dy-Mössbauer spectroscopy investigation of DyCrO₄

The rare earth (R) chromates RCrO4 form with the tetragonal zircon type structure (space group I41/amd). They are of interest because of competing ferromagnetic and antiferromagnetic super-exchange interactions between the 3d (Cr5+) and 4f (R3+) sites, believed to be responsible for the giant magnetocaloric effect observed recently for R = Gd, Dy and Ho [1,2].

The 161Dy-Mössbauer spectroscopy measurements on DyCrO4 reported here were prompted by earlier 169Tm- and 155Gd-Mössbauer spectroscopy results for TmCrO4 [3] and GdCrO4 [4], respectively. In both instances, it was necessary to interpret the Mössbauer spectra in terms of a superposition of two sub-spectra (approx. 80:20 intensity ratio) despite there being only a single crystallographic R(4a) site. In addition, the magnetic transitions exhibited first order character, which is contrary to bulk magnetic measurements.

DyCrO4 is reported to undergo a small crystal distortion to an orthorhombic (Imma) structure somewhere between 27 and 40 K and to order ferromagnetically at TC = 22.4 K [5]. Our 161Dy-Mössbauer results show a simple magnetically-split spectrum at 5 K. Compared to the reference Dy metal spectrum there is a small increase in the line width. However, contrary to the earlier Mössbauer work [3,4], a second sub-spectral component is not immediately evident. The spectra are paramagnetic above TC with the quadrupole splitting and Wegener relaxation broadening diminishing as the temperature increases to room temperature.

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