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Magnetic Properties of Cr_2AlB_2, Cr_3AlB_4, and CrB Powders

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Abstract

The MAB phases are ternary, atomically laminated compounds that crystallize with orthorhombic structures and consist of transition metal (M) boride sublattices interleaved with single or double layers of Al. To date, the magnetic properties of ferromagnetic Fe_2AlB_2 have been well-studied experimentally, but those of most end member MAB phases with different transition metals remain poorly understood. Herein, predominantly single-phase Cr_3AlB_4 and Cr_2AlB_2 powders, with minor amounts of CrB impurities, were synthesized by heating mixtures of chromium monoboride (CrB), aluminum (Al), and boron or CrB and Al under flowing Ar. These reactants were found to substantially suppress the formation of undesired phases in the Cr-Al-B system. The magnetic properties of Cr_3AlB_4, Cr_2AlB_2 and CrB powders were characterized. All compounds exhibit paramagnetic behavior down to 4 K, with susceptibilities that are very weakly temperature dependent at higher temperatures and a Curie-Weiss-like component prominent at low temperatures. Magnetization isotherms of the three compounds, showed approximately linear behavior above 5 kOe and no saturation of the magnetic moment up to 40 kOe, which is consistent with paramagnetism. The magnitude of the magnetic moments showed little variation with composition, on a per Cr atom basis. While the exact nature of the Curie-Weiss component is not entirely clear, we tentatively attribute it to dilute extrinsic impurities.

Keywords: MAB phases; borides; nanolayered structure; magnetic properties; paramagnetism

Declarations of interest: None