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Low-temperature magnetism of alabandite: Crucial role of surface oxidation

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Abstract

Manganese(II) monosulphide crystallizes into three different polymorphs (α-, β-, and γ-MnS). Out of these, α-MnS, also known as mineral alabandite, is considered the most stable and is widespread in terrestrial materials as well as in extraterrestrial objects such as meteorites.

In this study, a low-temperature antiferromagnetic state of α-MnS was investigated using macroscopic magnetic measurements as induced and remanent field-cooled (FC) and zero-field-cooled (ZFC) magnetizations and magnetic hysteresis. Both natural alabandite and synthetic samples show: (1) Néel temperatures in a narrow temperature range around 153 K, and (2) a rapid increase of the magnetization around 40 K. An anomalous magnetic behavior taking place at about 40 K was previously ascribed to the magnetic transition from a high-temperature antiferromagnetic to a low-temperature ferromagnetic state documented for non-stoichiometric α-MnS slightly enriched in manganese. However, our detailed microscopic observations and, in particular, oxidation experiments indicate that the anomalous magnetic behavior around 40 K is caused by the presence of an oxide layer of ferrimagnetic hausmannite (Mn_3O_4) on the surface of α-MnS rather than being an intrinsic property of nearly stoichiometric α-MnS.

Keywords: Alabandite (MnS), hausmannite (Mn_3O_4), troilite (FeS), magnetism