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MAGNETIC ORDERING AND SPIN WAVE DYNAMICS IN TRANSITION METAL ARSENIDES

BY

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DISSERTATION

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Materials Science and Engineering
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2021

Urbana, Illinois

Doctoral Committee:

Associate Professor Daniel P. Shoemaker, Chair
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k-maximal subgroups which are obtained by including or excluding the time reversal operator with the $\bar{6}$ symmetry element. Fig. 4.7 shows the refined fits to the two models from the 200 K neutron powder diffraction data. The fit to P$\bar{6}$ MSG in Fig. 4.7(b) does not contain the required intensity for the (021) magnetic peak. Hence, P$\bar{6}$′ is the correct MSG for cumnas at 200 K.

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CHAPTER 6

TWO-STEP MAGNETIC ORDERING INTO A CANTED STATE IN FERRIMAGNETIC MONOCLINIC Mn_3As_2

 In this work, I carried out SQUID and DSC measurements. I also carried out the magnetic structure refinement from NPD data and wrote the paper with help from coauthors. Bao Lam synthesized the samples and took SEM images.

6.1 Abstract

We report the magnetic structure of monoclinic Mn_3As_2 at 3 K and 250 K using neutron powder diffraction measurements. From magnetometry data, the Curie temperature of Mn_3As_2 was confirmed to be around 270 K. Calorimetry analysis showed the presence of another transition at 225 K. At 270 K, Mn_3As_2 undergoes a $k = 0$ ferrimagnetic ordering in the magnetic space group $C2/m$ (#12.58) with Mn moments pointing along b. Below 225 K, there is a canting of Mn moments in the ac plane which produces a multi-k non-collinear magnetic structure in space group $C2/c$ (#15.85). The components of Mn moments along b follow $k = 0$ ordering and the components along a and c have $k = [00\frac{1}{2}]$ propagation vector. The change in the magnetic ground state with temperature provides a deeper insight into the factors that govern magnetic ordering in Mn-As compounds.

6.2 Introduction

The Mn-As phase diagram contains a rich collection of phases with various magnetic structures [22, 43, 72–75, 103]. Most of the known compounds in this phase-space can be roughly divided into two groups. Compounds in one group are of the form $Mn_{2+n}As_{1+n}$ where, starting with stripes of square-planar Mn-As units running along a at $n = 0$, every additonal Mn-As involves adding an Mn-As octahedral

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