Structural Characterization of Manganese Octadecylphosphonate Langmuir-Blodgett Films by Grazing Incidence X-ray Diffraction

J. T. Culp,[1] H. Tostmann,[1] M. Davidson,[2] R. S. Duran,[1] D. R. Talham[1]

[1]*Department of Chemistry, University of Florida, Gainesville, FL, U.S.A.*
[2]*Department of Materials Science and Engineering, University of Florida, Gainesville, FL, U.S.A.*

Introduction

We have recently described the preparation of a magnetic Langmuir-Blodgett (LB) film containing an extended manganese-phosphonate network.[1] Characterization of this film by non-x-ray techniques has indicated that the inorganic network in this LB film is isostructural with bulk Mn phosphonates. To characterize the in-plane structure of this film, we have performed a grazing incidence x-ray diffraction (GIXD) study on the material.

Methods and Materials

A 16 bilayer film of manganese octadecyl-phosphonate (MnOPA) on glass was prepared as described previously.[1] The x-ray wavelength was 1.254 Å and made incident on the glass surface at a grazing angle to achieve surface sensitivity.
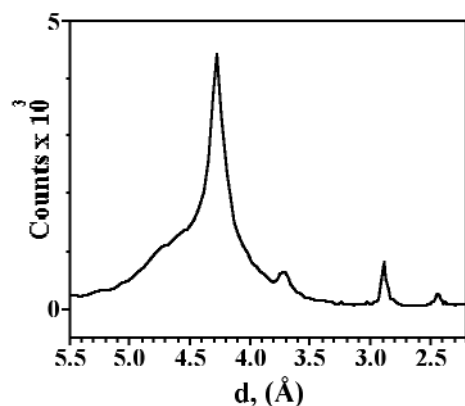

FIG. 1. GIXD pattern for 16 bilayer LB film of MnOPA, λ = 1.254 Å.

Results and Discussion

The bulk structure of manganese phenyl-phosponate is already known and described elsewhere.[2]

Our GIXD studies show that the thin film crystallizes in an orthorhombic cell with the manganese-oxygen network confined to a quasi-two-dimensional face-centered rectangular network. The unit cell parameters for the in-plane lattice are a = 5.73 Å and b = 4.94 Å. The GIXD pattern for the manganese octadecyl-phosphonate LB film is shown in Fig. 1. The diffraction pattern is dominated by a peak at a d-spacing of 4.27 Å, which arises from the packing of the octadecyl chains. The three other peaks in the diffraction pattern at d-spacings of 3.71 Å, 2.88 Å, and 2.44 Å arise from the manganese phosphonate network and can be assigned to the (1,1), (2,0), and (0,2) Bragg planes, respectively. The (1,0) and (0,1) reflections are absent due to the symmetry properties of the face centered lattice.

Analysis of the peak width indicates that the manganese network has a coherence length of over 175 Å. The in-plane inorganic network can be described by a centered rectangular cell similar to the solid-state derivative with a = 5.76 Å, and b = 4.88 Å. The peak at 4.27 Å indicates that the alkyl chains are packed into an oblique cell of dimensions a = 5.76 Å and b = 6.60 Å and γ = 139.7°. The peak at 2.88 Å is likely due to a contribution from the (1,0) plane of the alkyl chain lattice. A tilt angle of ~28° can be deduced from the dimensions of the alkyl chain unit cell and from the data obtained from Bragg rod scans on the alkyl chain peaks. The chains are tilted along the b axis, which coincides with the face diagonal of the manganese unit cell.

Acknowledgments

References

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