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A normal incidence X-ray standing wave study of sulphur adsorption on InP(110)

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Abstract

A normal incidence X-ray standing wave (NIXSW) study of room temperature in-situ S adsorption on InP(110) is described. The S atom XSW profile was measured by detecting S 1s photoemission yield for the (220) Bragg reflection. The average perpendicular distance of the S atoms from the InP(110) surface was determined to be 1.95 ± 0.02 Å. The coherent fraction f_c was found to be 0.67 ± 0.02, which upon annealing to 270°C increased to 0.82 ± 0.02. A (1×1) low energy diffraction (LEED) pattern was observed in all cases. Models for the adsorption geometry are discussed.

1. Introduction

The ability of chalcogens to modify III–V semiconductor heterojunction behaviour has been the subject of scientific and technological interest in recent years. Improvements in electronic and optical characteristics of III–V semiconductor devices treated with sulphides has been extensively reported and attributed to the reduction in the density of interface states [1]. Surfactant behaviour of chalcogens on GaAs(001) substrates has enabled improvements in the growth mode of both metal [2] and semiconductor [3] thin films and Schottky barrier heights of metal–semiconductor systems exhibit a greater sensitivity to the metal work functions when a chalcogen interlayer is incorporated [4].

Sulphur passivation of the III–V semiconductor surfaces arises from the modification of the surface electronic structure and can be explained in terms of the S/III–V semiconductor bonding geometry [5]. In this work the bonding geometry of the S/InP(110) system is investigated.

A number of different approaches to the formation of S/III–V overlayer systems have been taken. The S/InP(001) system, where the sulphur treatment has been achieved by a variety of ex-situ wet chemical sulphide etchants [5–11] or by the in-situ exposure to H_2S [12,13], has been studied extensively. Photoemission studies have shown that after room temperature treatment using a $(NH_4)_2S_x$ solution S bonds only to In [9] and a (1×1) low energy

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