The temperature dependence of Ag/InP(110) interface formation

1989 J. Phys.: Condens. Matter 1 SB247

(http://iopscience.iop.org/0953-8984/1/SB/062)

J. Phys.: Condens. Matter 1 (1989) SB247–SB248. Printed in the UK

The temperature dependence of Ag/InP(110) interface formation

C Stephens†‡, R Cimino§, K Fives‡, S Adamson‡, J Thornton‖, W Braun¶ and I T McGovern‡

† Physikalisches Institut der Universität, D-6000 Frankfurt am Main, Germany
‡ Department of Pure and Applied Physics, Trinity College, Dublin 2, Ireland
§ Fritz-Haber-Institut der MPG, Faradayweg 4–6, D-1000 Berlin 33, Germany
‖ Physics Department, University of Wales College of Cardiff, Cardiff CF1 3F1 3TH, UK
¶ BESSY, Lentzeallee 100, D-1000 Berlin 33, Germany

Received 13 April 1989

Abstract. The stepwise formation of the Ag/n-InP(110) interface has been investigated at room and low (<120 K) temperature using synchrotron radiation soft XPS in the coverage range 0.005–5 ML. Chemical, morphological and band bending effects were monitored and a comparison with the Ag/GaAs(110) interface is made.

As part of a series of photoemission studies of the temperature dependence of the formation of metal/semiconductor interfaces, Ag/n-InP(110) has been investigated. Clean unpinned InP(110) surfaces were prepared by cleaving and Ag was evaporated at rates less than 0.2 ML min^{-1} from a tungsten filament in UHV. For the LT experiments the InP was cooled to <120 K prior to cleaving. For each overlayer thickness, In 4d and valence band high-resolution (200 meV) photoemission spectra were recorded at $h\nu$ = 40 eV. A core level fitting technique† has been applied to the In 4d spectra. This analysis of the RT data reveals levels that we have assumed to be due to In in the bulk, surface and reacted states respectively in good agreement with previous work [1]. The LT spectra also reveal a reacted feature. However, this is less intense and its shift from the bulk feature is less than that at RT, which indicates that it is not due to metallic In.

Band bending was calculated from the binding energy of the bulk In $4d_{5/2}$ peak. No significant difference can be seen until the coverage is >0.02 ML. A pinning position very close to that of the final coverage position is then quickly reached at RT. However, at LT further band bending only occurs at coverages >0.3 ML and the final coverage pinning position is different to that at RT, being almost 200 meV lower. When the interface, formed at LT, is warmed to RT this difference is recovered.

The metallicity of the Ag overlayer was judged from the width of the Ag d bands [2]. It was found that a metal was formed more quickly at RT than at LT, which is consistent with the observation of cluster growth at RT, deduced from the In 4d intensity decay profiles. However, in contrast to what is found for Ag/GaAs(110) [2] the onset of

† Program supplied by Dr K Horn, Fritz-Haber-Institut.

0953-8984/89/SB0247 + 02 $02.50

metallisation is at higher coverages for both temperature regimes and the difference between the regimes is not as marked.

We conclude that the interface studied here is unlike Ag/GaAs(110) in that it is reactive in both temperature regimes. It appears that it is because of this reactivity that Ag metallic overlayers are not formed until coverage is higher and that the band bending is so complex. Furthermore, at higher coverages, the band bending cannot be explained in terms of the onset of metallisation.

References

[1] Petro W G, Kendelewicz T, Babalola I A, Lindau I and Spicer W E 1984 *J. Vac. Sci. Technol.* A **2** 835
[2] Stiles K and Kahn A 1988 *Phys. Rev. Lett.* **60** 440