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CARDIFF (WALES) R H WILLIAMS 30 SEP 87
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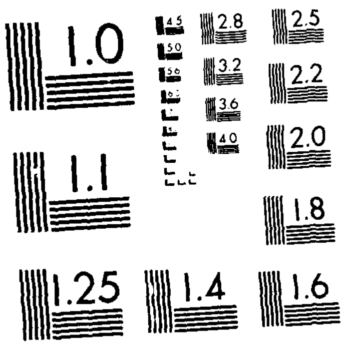
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METAL CONTACTS ON SEMICONDUCTORS

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The experiments on metal-semiconductor interfaces have been extended in the last six months using a range of techniques including Raman spectroscopy, photoemission spectroscopy, and transport measurements. The results obtained give complementary information and improve the understanding of Schottky barrier formation.

The deposition of Sb on clean cleaved InP (110) surfaces has been investigated most intensively. This Sb/InP exhibits highly unusual properties amongst metal-semiconductor interfaces. When Sb is deposited on InP (110) it forms an ideally abrupt interface, ie, no interdiffusion takes place and no new chemical phases are formed at the interface, since the first monolayer of Sb grows epitaxially on the InP substrate. Furthermore, Sb is a semimetal and cannot be regarded as a typical metal. These properties, however, make this system an highly interesting one and an ideal testbed for the different theoretical models of Schottky barrier formation.

→ (Indium Phosphide, Antimony)

The Raman study of Sb on n-type InP (110) is completed[1]. In this case electric field induced Raman scattering has been performed in situ to determine the band bending in InP while depositing Sb. The Raman active lattice vibrational modes have been used to monitor the morphology of the Sb overlayer. A strong correlation of the band bending with the overlayer morphology has been observed. Pronounced changes in band bending occur when a phase transition from the amorphous to the crystalline state take place in the Sb overlayer. This experiment has been performed at room and liquid nitrogen temperature. The different band bending behaviour at low temperature is entirely consistent with the different overlayer morphology. For Sb on p-InP (110) the Raman studies again show a strong correlation of band bending with the overlayer morphology[2]. The contrast to n-type InP where highly ohmic contacts are obtained, the barrier on p-type InP is close to the band gap of InP.

Furthermore, a highly interesting new feature has been observed in the Raman spectra of Sb. At ~ 1 monolayer of coverage a feature occurs at 185 cm^{-1} in the spectra which is due to a vibrational mode in the first epitaxially grown monolayer. This is an excellent prove for the sensitivity of the Raman technique. At low temperature, however, this feature does not occur indicating again a totally different behaviour of Sb absorption at low temperature. For a further study soft X-ray photoemission spectroscopy studies have been carried out at the synchrotron radiation source at BESSY in Berlin[3,4]. The investigations have been concentrated on the Sb absorption and the band bending at both room and liquid nitrogen temperature. Temperature dependent studies reveal the influence of reaction kinetics and activation energy on the Schottky barrier formation and are a very prominent object of interest. The band bending versus Sb-coverage behaviour found in this case is in excellent agreement with the Raman results. At room temperature three different contribution towards the Sb4d emission have been found, two of them being due to the two different site of Sb in the first epitaxial monolayer and the third one to the Sb deposited on top of this monolayer. In contrast the Sb spectra at low temperature show only one contribution indicating amorphous growth from the start. These results are again entirely consistent with the Raman results.

After a complete analysis of the photoemission data the comparison of the electronic structure and the morphology as revealed by SXPS and Raman spectroscopy respectively will allow for the most complete description of a metal-semiconductor system to date.

The picture is completed by a comprehensive study of the Sb/InP system [illegible] transport measurements[5].

In addition a study of Bi on InP has been started. Bi is of interest because of its similar electronic and structural properties to Sb. It, therefore, plays an important role as a comparable system. The transport measurements have already been performed and they reveal barrier heights close to those obtained for Sb on InP.

Raman spectroscopy studies have also been carried out on CdS. This II-VI semiconductor is more ionic than InP and it should reveal the influence of ionicity on the Schottky barrier formation. So far Au was deposited on CdS and large variations of the electric field induced Raman signal with externally applied bias have been observed. The CdS experiments are now carried out in situ to obtain the band bending versus coverage behaviour for the Sb/CdS system.

References

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