

The effects of caesium adsorption on the $\text{TiN}_{0.83}(100)$ Tamm surface state

This article has been downloaded from IOPscience. Please scroll down to see the full text article.

1989 J. Phys.: Condens. Matter 1 SB255

(<http://iopscience.iop.org/0953-8984/1/SB/065>)

View [the table of contents for this issue](#), or go to the [journal homepage](#) for more

Download details:

IP Address: 129.252.86.83

The article was downloaded on 27/05/2010 at 11:12

Please note that [terms and conditions apply](#).

The effects of caesium adsorption on the $\text{TiN}_{0.83}(100)$ Tamm surface state

P L Wincott†, P A P Lindberg and L I Johansson

Department of Physics and Measurement Technology, Linköping University, S-581 83 Linköping, Sweden

Received 27 April 1989

Abstract. The effects of Cs adsorption on a $\text{TiN}_{0.83}(100)$ surface have been investigated. Both work-function changes and xps-derived coverage data show behaviour typical for Cs overlayers on metallic substrates. The intensity and binding energy of a surface-localised $\bar{\Gamma}$ Tamm state relative to the TiN valence band, as monitored by ARPES, do not change with coverage. This is in contrast to the effect of Cs on the (100) surface states of W, Mo and Ta. We believe this behaviour can still be explained using the theoretical models for the latter systems by considering the nature of the TiN Tamm state.

In this experiment the effects of Cs adsorption, over the range 0.1–1.0 ML, on the electronic structure of the $\text{TiN}_{0.83}(100)$ surface are investigated. The (100) surface consists of equal numbers of Ti and N atoms on NaCl sites. LEED shows no overlayer ordering or substrate reconstruction. The surface coverage was monitored by plotting the relative increase in integrated peak area under the Cs $3d^{5/2}$ and Cs $3d^{3/2}$ XPS peaks. This increases linearly with Cs dosage up to a maximum, which remains unchanged with further Cs doses. The work function of the surface (monitored using UPS) first decreases rapidly from 3.05 eV to a minimum at 1.65 eV and then rises to a plateau at 1.8 eV, with increasing Cs dosage. The onset of this plateau coincides with the onset of the maximum in the XPS peak area. Such behaviour is quite typical for Cs adsorption up to monolayer coverage on a range of metallic substrates (see Soukiassian *et al* 1985a). Normal-emission ARPES (using He I and Ne I excitation) was used to monitor the TiN valence band during Cs dosing. An increase in peak intensity was observed at 5.1 eV binding energy (BE) attributable to Cs (cf Soukiassian *et al* 1985b). Surprisingly the TiN(100) Tamm state at 2.8 eV BE showed no intensity or BE changes (relative to the TiN valence band peaks). This state is highly localised in the surface plane and consists of 66% N $2p_{x,y}$ orbitals at $\bar{\Gamma}$ (normal emission) (Inglesfield *et al* 1982) pushed off the bulk N $2p_{x,y}$ bands by a bulk/surface potential shift on the clean surface. This peak shows an intensity decrease and shift to lower BE at >1 L dose of CO and O₂. The Cs 5p peaks at 12.1 eV and 13.9 eV BE also showed no movement (± 0.1 eV) with Cs coverage.

The above behaviour of the Tamm state is in direct contrast to the surface-localised Shockley states on the (100) W, Mo and Ta surfaces, which shift monotonically to about

† Permanent address: Interdisciplinary Research Centre in Surface Science and Department of Chemistry, University of Manchester, Manchester M13 9PL, UK.

1 eV higher BE following Cs adsorption, although the Cs 5p behaviour is identical to that of the W and Ta (100) surfaces (Soukiassian *et al* 1985a). The behaviour of the surface states on W, Mo and Ta has been explained using recent theoretical models (Soukiassian *et al* 1985a, Wu *et al* 1988) for a localised polarised bonding interaction of the Cs 6s orbitals with these states, which protrude well out of the surface planes. The same model can be used to explain the Tamm state and Cs 5p behaviour if the bonding interaction and resultant shifts in electronic potential for this system are also highly localised between the Cs adsorption and TiN surface planes (as in Soukiassian *et al* 1985a) giving no overlap with the planar-localised N 2p_{x,y} orbitals. This then indicates that the bonding interaction of Cs with this surface could be extremely localised and that the surface potential shift on the N atoms, which gives rise to the Tamm state, is unperturbed even by a complete Cs overlayer.

References

- Inglesfield J E, Callenas A and Johansson L I 1982 *Solid State Commun.* **44** 1321
Soukiassian P, Riwan R, Lecante J, Wimmer E, Chubb S R and Freeman A J 1985a *Phys. Rev. B* **31** 4911
Soukiassian P, Roubin P, Cousty J, Riwan R and Lecante J 1985b *J. Phys. C: Solid State Phys.* **18** 4785
Wu R, Chen K, Wang D and Wang N 1988 *Phys. Rev. B* **38** 3180