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N. Ernst, W. Drachsel, Y. Li, G. Bozdech, J. Block. ATOM-PROBE SPECTROSCOPY OF FIELD ADSORBED He AND Ne. Journal de Physique Colloques, 1986, 47 (C7), pp.C7-7-C7-9. 10.1051/jphyscol:1986702 . jpa-00225891

HAL Id: jpa-00225891

<https://hal.science/jpa-00225891>

Submitted on 1 Jan 1986

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ATOM-PROBE SPECTROSCOPY OF FIELD ADSORBED He AND Ne⁽¹⁾⁽²⁾

N. ERNST, W. DRACHSEL, Y. LI*, G. BOZDECH and J.H. BLOCK

*Fritz-Haber-Institut der Max-Planck-Gesellschaft,
Faradayweg 4-6, D-1000 Berlin 33, F.R.G.*SUMMARY

An electric field of the order of volts per Angström applied to the emitter-tip in a field-ion microscope induces the adsorption of He and Ne on metal surfaces at temperatures above 80 K /1/. To contribute to an improved understanding of this field enhanced binding, two experimental methods including probe-hole field ion microscopy are applied:

- (a) pulsed LASER induced (thermal) field desorption with subsequent time-of-flight mass analysis of the ions /2/ and
- (b) electron-stimulated field desorption of adsorbates as singly and multiply charged ions, which are mass analysed in a magnetic sector field and energy analysed in a retarding potential filter lens /3/.

With field strength values ranging approximately between 3V/Å and 5V/Å the yields of desorbed ions are measured as a function of surface temperature and of retarding voltage. Yield vs. temperature measurements display similar behaviour using either technique; the measured curves reflect the temperature dependence of the coverage of He and Ne adsorbed on selected W-surface atoms. Desorption energy values of both species increase from 120 meV to 260 meV as the local field strength is raised from 0.6 to 0.9 of the 80 K evaporation field strength (fig.1). The analysis of retardation curves enables a determination of binding distances as a function of field strength (fig.2). The experimental data are compared to results of recent quantum mechanical calculations of Kreuzer and Nath /4/ as well as to the experimental and theoretical results of Tsong et al.

⁽¹⁾Preliminary report

⁽²⁾Supported by the Deutsche Forschungsgemeinschaft, Sfb 6/86

* On leave from Dalian Institut of Chemical Physics, Chinese Academy of Sciences, Dalian, P.R. China

Fig. 1 - Desorption energy Q of field adsorbed helium atoms as a function of local field strength. F is scaled to the low temperature evaporation field F_{FEV} of ca. 55 V/nm. Circles and triangles represent data obtained by fitting measured temperature dependencies of desorbed ion yields using a Volmer adsorption model (mobile adatoms, hard balls). Desorption of adsorbed He as He^+ was either initiated by electrons (ESFD) or by a laser induced temperature pulse (LSFD). The full line was calculated by Kreuzer and Nath using a tight binding cluster approach /4/.

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◀ Fig. 2 - Equilibrium distance of a field adsorbed helium atom as a function of relative field strength (low temperature evaporation field strength $F_{FEV} \approx 55$ V/nm). The distance scale x_{eq} on the left applies to the experimental results obtained by retarding potential analysis of singly as well as doubly charged ESFD helium ions. The z_{min} -scale on the right is related to the theoretical curve of Kreuzer and Nath /4/. Note the difference between reference-zero positions x_{ref} shown in the inlet. x_{eq} -data measured on W(111) were fitted to the theoretical result giving $x_{ref}=0.08$ nm, being in good agreement with values calculated for the image plane position at a strongly charged jellium surface /5/.