COO-1383-1

PROGRESS REPORT

AEC CONTRACT AT(11-1)-1383

INTERACTIONS ON METALLIC SURFACES

by

Department of Chemistry and
James Franck Institute
The University of Chicago
Chicago, Illinois 60637

February 1, 1967 - February 1, 1968

Prepared by:

Robert Gomer
Professor of Chemistry

DISCLAIMER

PROGRESS REPORT

Adsorption of CO on Single Crystal Planes of Tungsten Field Emitters (T. Engel and R. Gomer)

The technique of measuring very small field emission currents (10^{-16} amperes or less) from microscopic single crystal planes of a field emitter has been worked out satisfactorily. The design used utilizes electron multiplication of the probe-hole current, either by means of Bendix Channeltrons, heated to adequate internal conductivity, or by means of conventional multistage Cu-Be electron multipliers of the Dumont-Fairchild design, with internal potential dividers. Some measurements of CO adsorption on the (110), (100), (111) and various high index faces of tungsten have been carried out. Results to date indicate the presence of electronegative virgin and beta states as well as electropositive alpha states on all the planes examined, although the details vary with crystal plane. A particularly interesting result is the fact that heating a CO beta layer on the 110 plane can produce under certain conditions a decrease in work function below the clean tungsten value. This may be associated with a radical rearrangement of the adsorbate. Much of the work carried out so far has been of an exploratory nature, and it is planned to greatly extend and consolidate these measurements before going on to another system or to electron impact desorption.

Adsorption of CO on Platinum (R. Lewis and R. Gomer)

A field emission study of CO adsorption on Pt was completed, and the results have been published.

Adsorption of Oxygen on Platinum (R. Lewis and R. Gomer)

After completion of the investigation of CO adsorption on Pt a study of oxygen adsorption on this substrate was initiated. This work is now nearing completion. Results obtained indicate the following: Oxygen is chemisorbed on Pt, probably with some surface reconstruction even at low temperature. Adsorption is electronegative with a work function increase of $\sim$1 eV. Heating to $T \geq 700^{\circ}K$ results in the formation of epitaxed surface phases, probably consisting of Pt oxides. At temperatures above $1100^{\circ}K$ a very persistent impurity oxide is observed even with high purity specimens; this probably contains Fe and/or Cu. Surface diffusion in the chemisorbed layer sets in at $450^{\circ}K$ with an activation energy of 27 kcal. This diffusion is of the moving boundary type, and suggests saturation of tight binding sites, i.e., some heterogeneity of adsorption sites. At low coverages a boundary-free diffusion is observed at $550\text{-}600^{\circ}K$ with an activation energy of 34 kcal. It is expected to complete and prepare this work for publication within the next two months.

Mass Spectrometric Measurements of Desorption (N. Avery and R. Gomer)

Considerable thought and time were devoted to the choice of spectrometer. Despite the relative ease of cryogenic operation of quadrupole or monopole instruments, a conventional sector instrument was finally chosen because of its greater versatility (i.e., the possibility of use with a field ionization or field desorption source), the fact that energy analysis is simpler,

and finally because of its relative freedom from mass discrimination. A Veeco GA4, nude source instrument, modified by addition of a pump-out arm in the collector end has been purchased, and is expected to arrive this month. Ancillary equipment has been designed and in part built, and tungsten single crystals to serve as adsorption substrates are now being prepared. It is hoped to have the instrument in at least exploratory operation in the near future.

Publications Resulting from Work Performed Under This Contract:

Chemisorption. R. Gomer, in Fundamentals of Gas Surface Interactions, p. 182-215 (Academic Press, New York, 1967).

Adsorption of CO on Pt, R. Lewis and R. Gomer, Nuovo Cimento V, 506 (1967).