THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE PHYSICS OF CRYSTALLINE SURFACES

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First Quarterly Status Report
For the Period 1 February-30 April 1967

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I. The relation between the structure of epitaxial films and surface and interfacial energies (A. K. Green and E. Bauer).

The efforts were concentrated on the study of the evolution of water vapor from alkali halides upon heating, which had been claimed to be a major factor in the epitaxy of f.c.c. metals on alkali halides (M. Harsdorff, Solid State Commun. 1, 218 (1963); 2, 133 (1964); Z. Naturforsch. 20a, 489 (1965); Fortschr. Miner. 42, 250 (1966)). The influence of subjecting NaCl single crystals at room temperature to controlled humidities (40-80%) for controlled times was investigated. A general result is that no water vapor bursts are observed unless the crystal is exposed to humidities larger than those corresponding to the vapor pressure of the saturated solution of NaCl. The gas evolution from crystals exposed to lower humidities was found to depend strongly upon the exposure conditions. The conditions (mainly the geometry) used in the preliminary experiments described in the last quarterly report produced misleading desorption peaks which could not be reproduced with improved techniques. The experiments are continuing.

Only a few epitaxy studies proper were made during the report period, mainly with the aim to obtain a better understanding of the influence of impurities in the vacuum system on the film orientation. By depositing Au at low pressures ($<3.10^{-9}$ torr) it was ascertained that the observed epitaxy of Au on vacuum cleaved KCl (in contrast to NaCl, where no epitaxy occurs) is not due to the pressure increase up to $1\text{-}5.10^{-8}$ torr during deposition. The influence of Na on the film growth was studied by depositing Na during and after Au deposition. Thick (100) oriented single crystal films of $NaAu_2$ could be obtained by co-deposition of Na and Au in situ in the UHV electron diffraction chamber, however no transmission electron microscope and diffraction study was possible because the films are not stable in atmosphere. Attempts were made to produce thick (111) oriented $NaAu_2$ single crystal layers on (100) oriented Au single crystal films with the aim to elucidate the nature of the surface layer giving rise to the 1/5 order reflection electron diffraction pattern reported earlier. Instead of obtaining the thick $NaAu_2$ layer expected upon Na deposition onto the "1/5 structure" a 1/3 structure was observed, in agreement with LEED work (see III).

II. Quantitative studies of the elastic and inelastic interactions of slow electrons with W single crystal surfaces (J. O. Porteus)

Installation of the electrostatic ion pump and related modifications of the vacuum system were completed. Vacua in the 10^{-11} torr range can now be produced and maintained, thus permitting extensive intensity vs. voltage measurements before sample contamination.

III. Determination of nature and structure of surface layers with low energy electron diffraction (E. Bauer)

Work on the interaction of CO and O_2 with W surfaces was continued with the goal to check the generality of the preliminary conclusions drawn from the study of the interaction of CO and O_2 with the W-{100} surface (see paragraph IV (3), Annual Report 1966/67). CO and O_2 adsorption on the W-{112} plane was studied. The results confirm the previous preliminary conclusions for the W-{110} plane but are open to the same objections as are the results for the {110} plane. Better crystals are being prepared and the experiments will be resumed when satisfactory crystals are available.

In connection with the epitaxy experiments (paragraph I) in which a 1/5 order reflection electron diffraction pattern was found on the Au {100} plane, the study of the corresponding LEED patterns ("5 x 1 pattern") from single crystal surfaces was resumed. This pattern is observed not only on Au {100} surfaces as described earlier, but also on Pt {100} surfaces. The present study is devoted to the latter surface and to the interaction of Na and K vapor with this surface. Na and K produce many different LEED patterns on this surface, including the "5 x 1 pattern" and some patterns which can be obtained by rotating the surface layer which produces the "5 x 1 pattern" about the surface normal. The results will be written up for publication as soon as the corresponding measurements on Au, Ag and Cu have been made.

IV. Relation between structure and electron emission properties of work function reducing layers on W {110} surfaces (G. Turner, E. Bauer).

The study of the BaO-W {110} system was continued during this period. The progress of the investigation, however, was seriously impaired due to a drastic deterioration in the resolution of the principle research instrument (ultra high vacuum electron microscope). The problem was finally correlated with existing, low intensity, AC magnetic fields in the room. An attempt is now being made to eliminate these fields or reduce them to an acceptable level.

Preliminary testing of the magnetic deflection system was completed and it is now ready for incorporation into the system. The field emission electron gun also received some effort during this period. Some new W field emission tips are in development for use in the present electron gun and electrode configuration.

V. Momentum exchange of atoms with well defined single crystal surfaces (W. Faith and E. Bauer).

The transition from the original Vacion pumped LEED system with molecular beam attachment to a diffusion pumped molecular beam system with LEED attachment is being made. The transition is near to completion; testing will be done in the next report period.

VI. Theory of low energy electron scattering (E. Bauer)

No work was done on this subject during the report period.