FIELD EFFECT RELAXATION OF CONTACT POTENTIAL DIFFERENCE BETWEEN STABILIZED VANADIUM PENTOXIDE SINGLE CRYSTAL AND PLATINUM SURFACES

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Field induced relaxations of contact potential difference were measured on stabilized V_2O_5—Pt system. Results indicated the presence of two sets of surface trapping levels.

Introduction

In two previous publications [1, 2] we have dealt with measurements of contact potential difference (C.P.D.) on freshly cleaved V_2O_5 single crystal surfaces oriented in (010) direction. The extremely large changes in C.P.D. observed, suggested to employ different methods to detect physical and chemical processes on surfaces of V_2O_5 single crystals. In the present work we deal with results obtained by measuring the relaxation of C.P.D. changes which follow the removal of an external electric field. In most respects, our results agree with those of PRATT and KOLM obtained for the case of Pt, Au, Ge and Si [3]. They found that the changes in C.P.D. due to the electric field relaxed logarithmically *vs* time (t). It could be deduced from experiments that the effect could not be attributed to adsorption and desorption of gas ions caused by the field, the changes rather reflected the occupancy of surface traps.

In the case of V_2O_5 single crystals we came to similar conclusions, though the field induced changes in C.P.D. were much larger, and the relaxation curves showed the presence of various trapping levels compared with Ge and Si.

Experimental set-up

Measurements of C.P.D. were performed with an apparatus using a vibrating condenser (Fig. 1). Samples (4) and Pt reference electrode (3) were put into a chamber which could be evacuated and/or filled with various gases. The apparatus was carefully shielded (5). The samples had cleaved surfaces which were stabilized in room atmosphere. The audio generator (1) and an electromagnet (2) served to produce the vibrations of the condenser. The mechanical resonance frequency was 127 cps.

The measurement of C.P.D. was performed as usual: *i)* either the compensating d.c. voltage (6) was adjusted to the minimum output of the detector system (7: preamplifier*, 8: wave-analyzer, 9: galvanometer) *ii)* or it was varied by 0.01

* For the high input impedance preamplifier sincere thanks are due to J. Łagowski (Institute of Physics of the Polish Academy of Sciences, Warsaw).

volt steps around the minimum value expected, and the correct C.P.D. was determined by interpolation from these V-type curves. The method *i)* was useful for detection of rather quick changes, while in other cases method *ii)* was preferred because of its higher accuracy (± 2mV in C.P.D.).

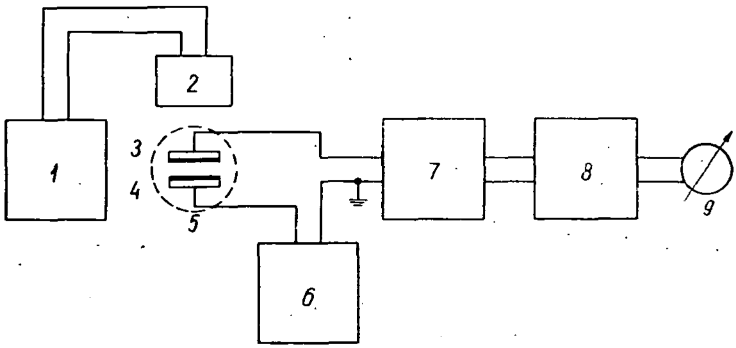

Fig. 1

The experiments were made in the following steps: 1) C.P.D. of the stabilized surface was measured, 2) an electric field (2.5 kV/cm) was applied between sample and Pt electrode for 15 minutes, 3) after removal of the field, C.P.D. was measured as a function of time. After reaching the equilibrium value of C.P.D. in some hours, the measurement was repeated with opposite polarity. The samples were always held on room temperature.

Results

Fig. 2 represents typical C.P.D. *vs* t curves on semilogarithmic scale. The first experimental point corresponds to $t=15$ sec (after removal of the electric field). The sign of the C.P.D. changes depended on the direction of the outer field (changes were positive/negative with Pt negative/positive). Changes of C.P.D. were large and equal in magnitude in vacuum and with dry gases of different pressures (Fig. 2). The presence of moisture resulted in diminution of C.P.D. changes, but contrary to the results obtained for Ge and Si by PRATT and KOLM the field effect was rather large in the case of V_2O_5 even with moisture contents of 50 *per cent*. The curves for different directions of the field were completely symmetric. In cases examined, the character of the curves was always the same. Three ranges could be observed: a rapid change followed by two logarithmically linear ranges of different slopes. These latter two portions of the curves set in at approximately the same time in each measurement ($t_1 \approx 1$ min, $t_2 \approx 8$ min, Fig. 2). This feature is very well to be seen on the curves corresponding to moist air.

In order to check our results, we also investigated the effect of field on C.P.D. between two Pt electrodes, under otherwise unaltered circumstances. The measured changes of C.P.D. are less by an order of magnitude in dry atmospheres compared