Measurements on the Effect of Light on Spurious Contact Potentials and "Trapped" Electrons

Changes in contact potential between a thoriated filament (operating at 1325°K) and a nickel collector can easily be measured by observing the thermionic current received on the collector as a function of the retarding potential. Shifts in the contact potential of such a nickel collector which depend on the time and on the previous history have been reported.[1] The surface model used to explain those results depended on the assumption that the potential barrier is of the "hill-valley" type shown in Fig. 13.[2] In detail it is assumed that on the nickel there is an adsorbed gas layer and on this is a layer of thorium atoms which have been evaporated from the filament during the process of activation. After long periods of time the surface attains the same state within 0.02 volt or less, independent of past history. This we will call the "normal" state. After a current of 2×10^{-6} is allowed to flow to the collector with an accelerating potential of 8.0 volts for ten seconds, the surface becomes 0.1 volt or greater *negative* with respect to the normal state but returns along exponential decay curves toward the normal state about 0.03 volt in 300 seconds. Many hours are required for complete recovery. The hypothesis has been made that the electrons are "trapped" in the valley of the potential barrier. It is at once obvious that if such were the case it should be possible to remove these trapped electrons photoelectrically. *Experiment* shows that the contact potential of this surface can be changed very appreciably by exposure to light and the normal state can be realized much more quickly than in the absence of light.

After a current of 20×10^{-6} amp. is allowed to flow to the collector with an accelerating potential of 100 volts for ten seconds, the surface becomes 0.1 volt or greater *positive* with respect to the normal state and again tends to return to the normal if left alone, but the time required is many hours. A supply of 8-volt electrons from the filament restores the potential very quickly however. It is also possible to accelerate the return to the normal condition by supplying the electrons photoelectrically from the nickel itself. That is, light again accelerates the return to the normal causing the surface potential to become *negative* with the time at a more rapid rate than is observed in the absence of light. Thus it seems as though the 100-volt electrons produced some "secondary" electrons by "ionizing" some of the atoms of the surface layer. About one ionized atom per thousand is all that would be required to produce the observed shift in contact potential. The electron currents from the filament to the collector at accelerating potentials of 8.0 volts or more were entirely reproducible and independent of the changes taking place at the collector surface which indicates that none of the changes observed can be attributed to changes in the surface of the emitting filament.

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July 19, 1933.

[1] W. B. Nottingham, Phys. Rev. **39**, 183 (1932).
[2] W. B. Nottingham, Phys. Rev. **41**, 793 (1932).

The Effect of Grinding and Etching on a Pair of Split Calcite Crystals

We have recently been making a search for a pair of calcite crystals suitable for making observations with a two-crystal x-ray spectrometer in the wave-length range 0.1–0.2 Angstrom. On account of the small Bragg angle it was necessary to have crystals at least 3.5 inches long. One pair (our No. 3), which had been split by the method used by Bergen Davis—saw-cut parallel to cleavage plane by milling machine—gave sufficiently narrow rocking curves in the (1, −1) position at 0.4A. At 0.2A, however, not only were the rocking curves much wider, but they were unsymmetrical,—and they varied, in both width and symmetry, from point to point along the face of the crystals, as was ascertained by limiting the beam by suitably disposed slits so that only a small part of the cleavage face was used. However, all these curves, taken from various parts of the crystal face, showed a maximum at very nearly the same angle, showing that the imperfections at 0.2A were not due to warping of the crystal planes, or other similar causes.

It occurred to us that this unsatisfactory behavior at 0.2A might arise from the fact that in spite of the care with which the crystal was split there was a series of steps on the cleavage face, and that therefore to the x-ray beam incident at the small Bragg angle, the crystal might present a surface made up largely of such steps rather than a series of reflecting *planes;* whereas the steps would be relatively less prominent at larger Bragg angles.

Accordingly, we ground the cleaved surface of each crystal to a plane (less than 10″ out of parallelism with the crystal planes); polished lightly with rouge; and then etched (for a few seconds) with an 0.7 normal solution of HCl, after the manner described by Manning.[1] The result of this first treatment was a slight increase in the width of the rocking-curve at 0.4A in comparison with the curves for the cleaved surfaces. But at 0.2A not only was the rocking curve narrower than before grinding and etching, but, more important from an experimental standpoint, it was constant as to shape, width and position for different parts of the crystal surface.

Since the removal of the large amount of material from the crystal face on first grinding might have caused considerable breakage of the surface planes, it was thought that a second very light grinding, with subsequent careful etching, might produce still narrower rocking curves. This conjecture was confirmed, as is shown by the data in Table I.

[1] Manning, Phys. Rev. **43**, 1050 (1933).

TABLE I. *Rocking curve widths in seconds (full width at half maximum) before and after grinding and etching.*

Wave-length	0.4A	0.2A	0.15A	0.2A
Position	1, −1	1, −1	1, −1	2, −2
Width before polishing and etching	4.6±0.2″	variable 7 to 14″		3.1″
Width after first polishing and etching	6.4±0.2″	constant 5.7±0.2″	4.5″	3.4″
Width after second polishing and etching	3.6″	2.7″	2.9″	1.65″

It is to be noted from Table I that the widths of the rocking curves decrease more or less regularly below 0.4A, contrary to the data shown by Allison,[2] whose results may perhaps be explained by the above "step effect."

It is recommended, therefore, that calcite crystals, for use on x-ray spectrometers at wave-lengths in the region 0.1–0.2A should be ground, polished and etched, unless the cleavage surfaces be exceptionally good. Such treatment produces crystals with very nearly homogeneous faces and with rocking curves as narrow as any reported for the best cleaved surfaces.

It is not improbable that, with these treated crystals a progressive change of rocking-curve width with time will be observed. We shall report on this point later.

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July 24, 1933.

[2] Allison, Phys. Rev. **41**, 1 (1932).