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ROUND LABORATORY

Operated By

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RESISTIVITY OF POLONIUM

(Ad Interim)

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INTRODUCTION

Apparatus for measuring the resistivity of polonium is described. This equipment has been built and tested. No resistivity measurements were made, however, because the method of determining the purity of the sample has not been perfected.

DISCUSSION

The resistivity of polonium is to be measured to see if there is a discontinuity in the resistance curve in order that the change from α to β crystal form near room temperature can be checked, since X-ray data has implied that these crystal forms exist. It is also of interest to see if polonium is a semiconductor or a metallic conductor. The possibility exists that polonium could be a semiconductor; but because of electrons formed by alphas in the polonium decay, a low apparent resistance could occur. It is proposed that normal semiconductors be exposed to a similar flux of alphas to find the change in resistance resulting from that flux.

The resistivity measurement is to be made in a manner similar to that used by Maxwell and Beamer¹ in their polonium resistivity work. However, the apparatus is designed so that the temperature of the film can be varied from -196°C . to about 200°C . Figure 1 shows the apparatus for measuring the conductivity of thin films of metal. The upper portion of Figure 1 shows a standard potentiometer arrangement to measure the current through the metal film by measuring the potential drop across the standard resistor and to obtain the resistance of the film from this current and the potential drop between the potential electrodes terminating in the metal film (see Figure 2). If the dimensions of the film are known, the resistivity of the film can then be computed.

The temperature of the film is controlled by circulating a liquid through the tube that supports the electrodes and film. The liquid is pumped by means of a centrifugal pump through a large coil submerged in a Dewar flask or large beaker into the apparatus. By regulating the temperature of the liquid in the beaker or by varying the type of refrigerant in the Dewar flask and the speed of the pump, the temperature of the film may be determined.

The metal film is formed by condensation of the metal on the electrode area. If a vacuum of the order of 1×10^{-5} mm. of mercury is obtained in the system, the metal will effuse from the quartz-lined nickel crucible as a molecular beam onto the electrode surface. It was found by experiment that the effusion arrangement illustrated in Figure 1 is not practical, since too much heat is radiated to the glass tube vacuum walls resulting in reflection of the metal atoms. A preferred design is shown in Figure 3, where the vacuum walls are

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RESISTIVITY APPARATUS

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Figure 1

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Figure 2

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VIEW OF ELECTRODE AREA AND CADMIUM FILM

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UNCLASSIFIED RESISTIVITY APPARATUS

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cooled by liquid air. The details of the effusion furnace are also diagrammed. A platinum mask is placed very near the electrode area and determines the area of the condensed film. In this apparatus the nickel crucible will be heated by induction, and its temperature measured by the thermocouple in the position shown. The beam was to have been shut off by a magnetically operated shutter, but since it would have to be so close to the induction heating coil it was left out of the new design. The resistivity of different film thicknesses will have to be found by separate runs.

In the initial experiments cadmium metal has been used. This metal was chosen because it has a vapor pressure very near that of polonium and in addition has a transition point in the neighborhood of 38°C. Cadmium has been used in several initial experiments to check the effusion properties of the design. The cadmium to be used in the conductivity measurements was purified by reduction in a hydrogen atmosphere and was doubly vacuum distilled into a quartz tube which was sealed off from the system. Polonium is to be prepared in the same way, and its purity is to be checked by the vacuum balance method of purity assay.

An alpha ray, pin-hole camera (Figure 4) was designed and built. This camera is to be used to check the distribution of the polonium in the film. The resistivity film holder will be put in the camera and fixed in position by means of a 34/45 ground taper joint. The camera will then be evacuated and the photographic film exposed. An optical densitometer will then determine the exposed density of the photographic film.

The amount of polonium in the film will be found by dissolving it off with acid. The activity in the acid can then be determined by counting or if the volume is small enough by the calorimeter method.

REFERENCE

1. Maxwell and Beamer, Physical Properties and Crystal Structure of Polonium, LA-604.

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Figure 4 MLM-296
—ALPHA RAY PIN-HOLE CAMERA—

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