THEORY OF HIGH FREQUENCY RECTIFICATION BY SILICON CRYSTALS

Introduction

This paper deals only with those phenomena in high frequency rectification which are due to the combined effect of conductivity and capacity. It does not deal with the solid state theory of rectifying contacts which is treated in a separate report (43-12). A knowledge of that report is not necessary for the understanding of the present paper.

In the report mentioned it is shown that a consistent theory of the contact can be obtained by assuming that the surface of the crystal has the same chemical composition as the interior, i.e., without the assumption of an artificial blocking layer. It is necessary to assume a high dielectric constant such as is usually found for non-metallic elements. In all numerical calculations we shall assume a dielectric constant $\epsilon = 10$. Using the measured number of conduction electrons for "average" silicon, the thickness of the boundary layer then comes out to be of the order of 10^{-6} cm. The motion of electrons through the boundary layer is essentially like that in a diode, since the mean free path of electrons is about 5×10^{-6} cm., i.e., several times the thickness of the layer.

The characteristics of the contact for D.C. are the usual ones: in the forward direction the current increases exponentially with the applied voltage up to a certain voltage φ_c; if the voltage is greater than φ_c, any amount of current can pass through the contact (remember, however, the bulk resistance discussed below!). In the backward direction, the current reaches a small saturation value for a back voltage of about .1 volt; if the back voltage is increased to about one volt or more, breakdown occurs due to the Schottky effect (image force.)

The actual resistance in the forward direction for voltages greater than φ_c is determined by the bulk resistance of the crystal. If the contact area is a