Letters to the Editor

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Optical Absorption of Single-Crystal Strontium Titanate

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A BRIEF investigation of the optical absorption of single-crystal strontium titanate in the spectrum range from 0.35 to 15.0 microns has been carried out in this Laboratory. The crystals measured were obtained through the courtesy of National Lead Company where they were grown by the flame fusion technique.[1] Data from 0.35 to 1.0 microns were taken with a Beckman Model DU spectrophotometer while the region from 1.0 to 15.0 microns was investigated with a Perkin-Elmer Model 12C spectrophotometer equipped with rocksalt optics.

The absorption coefficient was obtained by measuring optically polished samples of several thicknesses ranging from 0.20 mm to 17.0 mm. By applying the equation for the absorption coefficient,

$$a=\ln(T_1/T_2)/(x_2-x_1),$$

where T_1 and T_2 are transmission values for samples of thickness x_1 and x_2, respectively, a was computed as a function of wavelength throughout the range where it was possible to detect transmission in the samples measured. The results of these calculations are shown in Fig. 1.

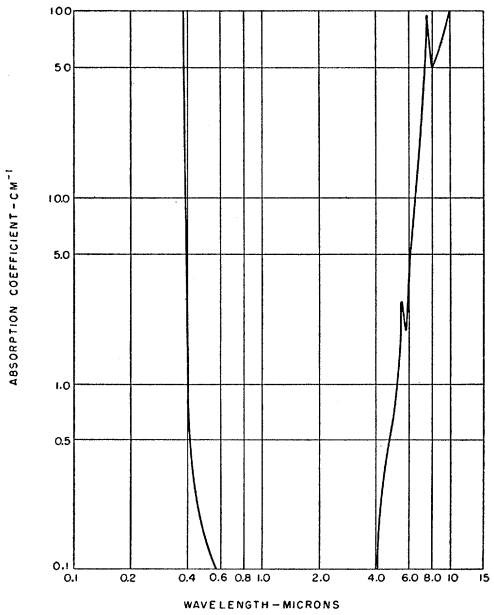

FIG. 1. Absorption coefficient of single crystal $SrTiO_3$ as a function of wavelength.

The ultraviolet cutoff for strontium titanate is found to be 0.385 micron. This edge is probably associated with the energy gap from the valence band to the conduction band, and therefore this gap is evaluated by optical methods to be 3.22 electron volts. Because of the low absorption in this material, a transmission of better than 70 percent was obtained from 0.55 to 5.0 microns for a 1.0-mm thick sample. A maximum transmission of 80 percent was found at 4.0 microns for this sample. It is possible that this high transmission in the near infrared could make strontium titanate applicable as a window material for this spectral region. The absorption bands observed at 5.5 and 7.5 microns are presumably due to vibrations of the crystal.

According to Linz,[2] an absorption is observed at about 2.0 microns for strontium titanate single crystals. However, no such absorption was observed at this laboratory. Since the crystals studied here and the ones reported on by Linz were obtained from the same source and grown in the same way, no explanation is advanced at this time for this apparent discrepancy in transmission data.

[1] L. Merker and L. E. Lynd, U. S. Patent 2,628,156, February 10, 1953 (unpublished).
[2] Arthur Linz, Jr., Phys. Rev. **91**, 753 (1953).

Hall Mobility of Electrons and Holes in Silicon*

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THE mobility of charge carriers has been investigated as a function of the resistivity in a number of silicon single crystals,[1] all of which were grown from Dupont hyperpure material. The n-type crystals ranged in resistivity from 0.01 to about 94 ohm cm and the p-type crystals from 0.025 to about 110 ohm cm.

Slices were cut from the crystals perpendicular to the direction of growth, and proper sample shape[2] was obtained by using an ultrasonic machine tool.[3] All data were taken at room temperature (295 Kelvin).

The measured values ($R\sigma$) for the mobility as a function of resistivity are given for electrons in Fig. 1 and for holes in Fig. 2.

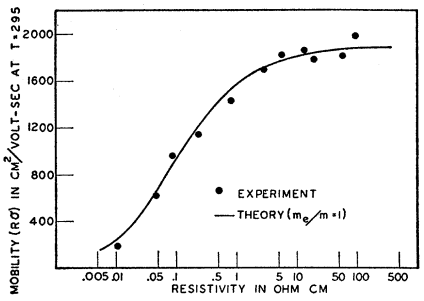

FIG. 1. Hall mobility of electrons in silicon as a function of resistivity.

The solid line represents the theoretical relationship which was calculated from the Herring[4] expression for the impurity mobility μ_I:

$$\mu_I=\frac{2^{7/2}|\kappa^2(kT)^{\frac{3}{2}}}{\pi^{\frac{3}{2}}|m_e^{\frac{1}{2}}e^3N_I}\frac{1}{\ln(1+b)-b/(1+b)},$$

where

$$b=\frac{6}{\pi}\frac{\kappa m_e k^2T^2}{n\hbar^2e^2}.$$

In this formula the dielectric constant κ was taken as 12, the absolute temperature was $T=295$, and the effective mass m_e of the charge carriers was the electron mass. The density of the ionized impurities N_I was assumed to be equal to the density of conduction electrons n. The theoretical Hall mobility plotted in Figs. 1 and 2 was obtained by combining the lattice mobility μ_L and the im-