Study of the $E_1$ and $E_1 + \Delta_1$ Edges of GaSb by Electroreflectance with Franz-Keldysh Oscillations and Low-Field Electroreflectance in High Magnetic Fields (*).

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Summary. — We have observed Franz-Keldysh oscillations in the electroreflectance (ER) spectra of GaSb above the $E_0 + \Delta_0$, $E_1$ and $E_1 + \Delta_1$ edges. The theory of Aspnes allows us to extract band parameters of the $E_1$ and $E_1 + \Delta_1$ edges from the values of the $E_0 + \Delta_0$ parameters known from previous magneto-optical measurements. We have also performed low-field ER of this compound in magnetic fields up to 180 kG in order to complete these results. The data were taken in the Faraday configuration by extracting $\sigma^+$ and $\sigma^-$ spectra with the magnetic field in several crystallographic directions. We have considered linear $k$ terms and nonparabolicity in order to interpret the experimental results. The data obtained with the magnetic field (MER) are compared with those obtained by intermediate-field ER.

Two complementary surface barrier electroreflectance techniques have been utilized to extract band parameters at the $E_1$ and $E_1 + \Delta_1$ edges of GaSb. At high electric fields Franz-Keldysh (FK) oscillations are seen and yield infor-

marion on the effective masses (1) parallel to the electric field. At low electric fields the FK oscillations disappear and the spectra obtained become sufficiently sharp so that in a high magnetic field a structure due to transitions between Landau levels is observed, giving information on the effective masses perpendicular to the magnetic field.

In fig. 1 experimental results obtained by the first method are shown. Since the absolute values of the surface electric fields we applied are not known precisely, we have combined the theoretical analysis of the FK oscillations of Aspnes (1) with experimental values obtained in magneto-piezo-reflectance by REINE (2) at $E_0 + \Delta_0$ in order to extract the $E_1$ and $E_1 + \Delta_1$ reduced effective masses, reported in a previous work (3) (see table I).

Figure 2 shows, on the other hand, magneto-electro-reflectance spectra obtained at 180 kG in the Faraday configuration for $\sigma^+$ and $\sigma^-$ polarizations and $T=18$ K. These data are shown in reduced form in fig. 3, where the reduced inverse effective masses obtained from the energy separation of adjacent peaks are plotted. The lines are least-square fits to the experimental points, using the $k \cdot p$ theo-

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