OPTICAL PROPERTIES OF THIN FILMS
AND OPAQUE SOLIDS.

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The work involved in this thesis is an account of the manner in which the optical reflectance and transmittance of thin films of Ge, and the reflectance of opaque films and polished specimens of metals such as Au, Ni, Co and Mo relate to their optical constants and hence their band structures.

Chapter 1 presents introductory theory on band gaps and electronic transitions in metals and semiconductors and a short review of various methods of determining their optical constants.

Chapter 2 gives a brief description of the experimental methods used.

The changes in the optical constants \( n \) and \( k \) of thin films of Ge as they are converted from the amorphous to the crystalline state have been determined for the spectral region between 0.62 to 1.2 eV by the normal incidence reflectance and transmittance method and are discussed in Chapter 3. For the amorphous state of Ge an interpretation is made according to the Mott and Davis (1977) model of energy bands. A detailed study has been made of the effects on the optical constants of annealing amorphous films from 290 to 760°C and of preparing films at higher substrate temperatures (300 to 600°C). The energy gaps of both amorphous and polycrystalline films of Ge, and of amorphous films converted to the polycrystalline state by annealing, have been calculated from the relation \( (E_n)^{1/2} = c(E - E_g) \).

In Chapter 4 a method is given for evaluating the optical constants of Ge within the region 1.8 to 15 eV by using Kramers-Kronig dispersion relations. For reflectances at high energies above
three similar extrapolation formulae have been investigated in attempts to improve extrapolation procedures by using additional parameters which are determined from the directly measured values of the optical constants within the region 1.8 to 4.0 eV.

Chapter 5 gives an introduction to the single and double layer formulae derived by Tomlin (1972, 1978) for determining the optical constants of metals. The effects of errors in the measurement of reflectances are considered.

Measurements of the optical constants of opaque Au films in the region 1.7 to 4.2 eV are presented in Chapter 6. The results are discussed and the features of the spectra due to interband transitions are identified.

The optical properties and interband transitions in the region 0.62 to 4.0 eV of the transition metals Ni, Co, and Mo are discussed in Chapter 7 and some tentative identifications of optical features are made. Polished specimens of Co and Ni have almost identical band structures and polished specimens of Mo and opaque Mo films have some similarities with Ni and Co.

Appendices contain a brief account of some preliminary observations of the optical properties of steric acid films, and contain details of Kramers-Kronig calculations.