

3. Optical Properties of Electronic Materials: Fundamentals and Characterization

Jan Mistrík, Safa Kasap, Harry E. Ruda, Cyril Koughia, Jai Singh

Light interacts with materials in a variety of ways; this chapter focuses on refraction and absorption. Refraction is characterized by a material's refractive index. We discuss some of the most useful models for the frequency dependence of the refractive index, such as those due to Cauchy, Sellmeier, Gladstone–Dale, and Wemple–DiDomenico. Examples are given of the applicability of the models to actual materials. We present various mechanisms of light absorption, including absorption by free carriers, phonons, excitons and impurities. Special attention is paid to fundamental and excitonic absorption in disordered semiconductors and to absorption by rare earth, trivalent ions due to their importance in modern photonics. We also discuss the effect of an external electric field on absorption, and the Faraday effect. Practical techniques for determining the optical parameters of thin films are outlined. Finally, we present a short technical classification of optical glasses and materials.

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3.1 Optical Constants

The changes that light undergoes upon interacting with a particular substance are known as the optical properties of that substance. These optical properties are influenced by the macroscopic and microscopic properties of the substance, such as the nature of its surface and its electronic structure. Since it is usually far easier to detect the way a substance modifies light than to investigate its macroscopic and microscopic properties directly, the optical properties of a substance are often used to probe other properties of the material. There are many optical properties, in-

cluding the most well known: reflection, refraction, transmission and absorption. Many of these optical properties are associated with important optical constants, such as the refractive index and the extinction coefficient. In this section we review these optical constants, such as the refractive index and the extinction coefficient. Books by *Asakchi* [3.1], *For* [3.2] and *Sinuous* and *Porter* [3.3] are highly recommended. In addition, *Asakchi* also discusses the optical properties of III–V compounds in this handbook in Chap. 30.

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Rosina Ehm

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Electronic Structure and Magneto-Optical Properties of Solids Victor Antonov, Bruce Harmon, Alexander Yaresko, 2006-05-05 The aim of this book is to review recent achievements in the theoretical investigations of the electronic structure optical magneto optical MO and x ray magnetic circular dichroism XMCD properties of compounds and Multilayered structures Chapter 1 of this book is of an introductory character and presents the theoretical foundations of the band theory of solids such as the density functional theory for ground state properties of solids including local density approximation LDA It also presents some modifications to the LDA such as gradient correction self interaction correction LDA U method orbital polarization correction GW approximation and dynamical mean field theory The description of the magneto optical effects and linear response theory are also presented The book describes the MO properties for a number of 3d materials such as elemental ferromagnetic metals Fe Co and Ni and paramagnetic metals in external magnetic fields Pd and Pt some important 3d compounds such as XPt_3 X V Cr Mn Fe and Co Heusler alloys chromium spinel chalcogenides MnB and strongly correlated magnetite Fe_3O_4 It also describes the recent achievements in both the experimental and theoretical investigations of the electronic structure optical and MO properties of transition metal multilayered structures MLS The book presents also the MO properties of f band ferromagnetic materials Tm Nd Sm Ce and La monochalcogenides some important Y Electronic Structure and Optical Properties of Semiconductors Marvin L. Cohen, James R. Chelikowsky, 2012-12-06

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Electronic Structure and Optical Properties of Si-Ge Superlattice Abdussalam Ebrahim Mansur, University of Newcastle upon Tyne. Department of Physics, 1997

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