UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Solid State Optical Spectroscopy

2122-1-F1701Q110

Aims

The main goal of the course is giving the tools for the description of the optical properties of solids, to complete the overall picture of solid state physics.

Specific aims of the course:

- discussing light propagation in solids
- introducing the proper concepts and physical quantities for the description of the optical properties of solids
- discussing the characteristic optical properties of different solid materials
- illustrating the main optical spectroscopy techniques and the working principles of instruments

Contents

- Light propagation in solids

- Dielectric response of solids and models

- Optical spectroscopy techniques

Detailed program

Electromagnetic waves in solids and dielectric response
References to Maxwell's equations in vacuum and in the matter; wave equation; electromagnetic spectrum. The propagation of light in the matter; complex dielectric function and refractive index; dielectric tensor and anisotropy; wave equation in anisotropic media. Microscopic origin of the dielectric response; Lorentz and Drude models; dispersion relations, Kramers-Kronig relations, screen effects, local field, Lorentz-Lorenz and Clausius-Mossotti equations. Cauchy and Sellmeier models; effective medium theories. Typical response of dielectrics, metals, semiconductors. Non linear optical response (elements).

Spectroscopy
Thick and thin films; reflectance, transmittance, absorbance; Lambert Beer's law, T and R at normal incidence. Interfaces, Fresnel coefficients, multiple interfaces; multilayer and matrix method. Brewster's angle. Total internal reflection, evanescent waves.

Techniques and instrumentation
Sources, dispersive elements, filters and polarizers, detectors; principles of Fourier transform instruments; measurements of reflectance, transmittance, absorbance, single and double beam instruments. Polarization of light (recalls). Transmittance and reflectance in polarized light. Jones formalism and principles of spectroscopic ellipsometry. Time-resolved emission and emission spectroscopies. Raman spectroscopy.

Prerequisites

Classical electromagnetism and basic concepts of condensed matter physics.

Teaching form

Lessons and examples.

Textbook and teaching resource

1. J. Peatross and M. Ware, *Physics of Light and Optics* (2015), available at optics.byu.edu

2. O. Stenzel, *The Physics of Thin Film Optical Spectra* (Springer, 2005)

3. G. Giusfredi, *Manuale di ottica* (Springer, 2015)

4. H. Kuzmany, *Solid State Spectroscopy* (Springer, 2009)

5. M. Fox, *Optical Properties of Solids* (Oxford University Press, 2010)

6. N.V. Tkachenko, *Optical spectroscopy* (Elsevier, 2006)

7. M. Born and E. Wolf, *Principles of Optics* (Pergamon Press, 1989)

8. F. Wooten, *Optical Properties of Solids* (Academic Press, 1972)

9. J. Garcia Solé, L.E. Bausà, and D. Jaque, *An Introduction to the Optical Spectroscopy of Inorganic Solids* (Wiley, 2005)

Molti argomenti si trovano anche sulle Lectures on Physics di Feynman, di piacevole lettura: www.feynmanlectures.caltech.edu/

NOTA: i testi 1, 2 e 3 sono scaricabili in formato pdf dal sito della biblioteca; il testo 4 è disponibile gratuitamente online.

See also: The Feynman Lectures on Physics, at www.feynmanlectures.caltech.edu/

NOTE: textbooks 2, 3 and 4 can be downloaded as pdf files from the library website; textbook 1 is also freely available.

Semester

II semester

Assessment method

Oral exam.

Office hours

Upon request, by e-mail: adele.sassella@unimib.it