UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Solid State Optical Spectroscopy

2425-1-F1701Q110

Aims

The main goal of the course is giving the tools for the description and measurement 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 those of different solid materials
- presenting reflection and transmission at an interface and from thick and thin films
- illustrating the main optical spectroscopy techniques and the working principles of instruments

Contents

- Dielectric response of solids

- Interfaces, thin films and optical spectroscopy

- Instruments and techniques for optical spectroscopy

Detailed program

Dielectric response of solids
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. Semi-classical model for the dieletric response. Typical response of dielectrics, metals, semiconductors. Non linear optical response (elements).

Interfaces and films
Interfaces, Fresnel coefficient, T e R at normal incidence; Brewster angle. Total internal reflection, evanescent wave. Thick slabs and thin films; transparent, absorption, anisotropic film; film on a substrate. Multilple interfaces, multilayers and matrix method.

Techniques and instrumentation
Sources, dispersive elements,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. 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)

10. E. Hecht, *Optics* (Addison Wesley, 2002)

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

Most topics can be found also in Lectures on Physics by Feynman, absolutely enjoyable: www.feynmanlectures.caltech.edu/

Semester

II semester

Assessment method

Oral exam.
Discussion about some of the subjects of the lectures, starting from a subject at choice.

Once registered, the students can ask for delaying the exam of a few days. Otherwise, date, hour, and room are the ones published in "segreterie online".

Office hours

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

Sustainable Development Goals

QUALITY EDUCATION