Handbook of Ellipsometry

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Another book on ellipsometry? Yes, and certainly a heartily welcomed one! To date, R.M.A. Azzam's and N.M. Bashara's "Ellipsometry and polarized light" was one of the standard books in this field, however, very technical and now already a quarter century old. Therefore, in a rapidly developing field of physics, it's not too early to edit a new textbook. The one presented here has the advantage to provide a lot of background information in text form to accommodate the researcher. Ellipsometry is a rapidly growing spectroscopic method, widely used to measure optical anisotropy, chemical composition, and the roughness of surfaces. Already in the late 1800's, Paul Drude identified ellipsometry as a high precision method to measure the thickness of optical films down to angstrom resolution. Fast data transmission is via optical fibres today. They show a sophisticated refractive index profile and the interaction of light when entering and propagating in the fibre can only be investigated by ellipsometry. The book also covers the topics of protein chip technology and the materials science of semiconductor thin films.

The handy 870 page book is structured into four parts: Theory, instrumentation, application, and emerging areas. The individual two to four chapters in each part are written by separate authors, experts in their field. Each chapter in the book closes with a reference section and sometimes with suggestions for further reading.

Starting from the Maxwell equations, part one introduces the mathematical and physical formalisms required to understand and calculate the optical effects in polarimetry. The effect of reflection or transmission of light on its polarization state is outlaid. Then follows an excursion to solid state physics to relate the optical phenomena to the band model. Finally, a whole chapter is dedicated to read spectroscopic data and perform meaningful fits to experimental data to extract materials parameters.

Part two is on instrumentation. First, the basic polarizing components are presented and how they interact with a polarized light beam. The components are assembled to form a polarimeter where the orientation angles are set by hand. The next chapters treat more sophisticated ellipsometry with a rotating polarizer or analyzer and by photoelastic modulators. Finally, multichannel (i.e. simultaneous multiwavelength) ellipsometry is described as an increasingly used tool for the full characterisation of thin optical layers.

Part three presents critical reviews on applications of ellipsometry. Since in the early 60ies transistors were grouped on single Si chips, SiO_2 has played the role of a passivating material. The measurement of the SiO_2-layer thickness and its properties for process control is a classical application of ellipsometry. The second chapter in this part introduces the concept of Generalized Ellipsometry. This concept comes into play when characterising stratified media, biaxial films, and

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magneto-optical layers, as they are widely use in contemporary storage media.

Finally, part four shows, where the future development and application of ellipsometry will go to. First, two spectroscopic techniques operating at the extremes of the frequency scale are described: VUV (vacuum ultraviolet) ellipsometry which became important for the design of thin films for the 157nm photolithography and spectroscopic infrared ellipsometry. The latter covers the wave number range from 400 to 5000 cm^{-1} by combining Fourier transform spectroscopy with photometric ellipsometry. The book concludes with a most interesting survey on biosensors. This chapter shows how thin and thick layers of biomaterial interacting with smooth or rough substrates can be characterized by ellipsometry, both for the design of the sensors and the readout of the information contained therein.

In summary, the book is highly recommended for everybody who would like to know more about a material than just its refractive index. It guides the student who makes his or her first steps in ellipsometry equally well as the scientist who is a specialist in another field but uses ellipsometry as a tool for materials characterisation.

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