



**TUTORIAL**  
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**DATA ANALYSIS**



 JA. Woollam

# Ellipsometry Data Analysis A Tutorial

**Harland G. Tompkins**



## **Ellipsometry Data Analysis A Tutorial:**

Analysis of Spectroscopic Ellipsometry Data from Patterned Structures for Etching Process Monitoring and Control Wei Kong, 2001     Optimising Neutron Reflectometry Experiments through Sensitivity-Guided Data Analysis and Substrate Engineering Ivan Yakymenko, 2025-09-29

Neutron reflectometry NR is a technique used for probing the structure of buried interfaces and is particularly useful for studying the structure of surfaces and thin films within condensed matter systems. In the context of soft condensed matter lipid bilayers deposited on the surface of a solid substrate are heavily investigated as they can be designed to mimic different kinds of biological membranes. NR can be used to obtain structural properties such as thickness, solvent penetration or roughness of the adsorbed layers at interfaces. Moreover, by fitting the neutron reflectivity data to a model of neutron scattering length density (SLD), it is possible to determine the chemical composition of the films. In addition, due to the neutron's magnetic moment, it is possible to obtain the magnetic properties of a material by using polarised neutron beams and analysing the magnetic SLD depth profile. When fitting model parameters to experimental NR data, it is often challenging to decouple material-related parameters such as real and imaginary parts of the SLD and structural parameters like layer thicknesses and interface roughness. In optical photonic analysis, many methods have been developed to solve such correlation problems. One approach is referred to as multiple sample analysis (MSA), where two or more similar samples but with some parameters varied are measured. In the subsequent analysis, two or more corresponding models are fitted simultaneously to the measurements. In NR, there is an analogous standard technique of contrast variation, where the problem to decouple parameters is even more challenging since only intensities are measured with the loss of phase information, often termed the phase problem. Furthermore, an additional possibility to find unique solutions of the SLD from reflectivity data is to use switchable magnetic reference layers (MRL). In the layered thin film structure, a MRL is deposited whose characteristics can be controlled and therefore known beforehand. By applying an external magnetic field, this layer is magnetised in a specific direction and probed with neutrons of different spin states. The MRL thus provides additional measurement data and a possibility to decouple the model parameters. Since NR experiments are both extremely expensive to run as well as difficult to access, it is important to make the best possible use of the experimental time. Reducing measurement time while maintaining high precision is key to expanding the applicability of neutron scattering techniques. To improve the effectiveness in extracting useful information from neutron reflectivity experiments, we have designed substrate assemblies comprising a Si slab, a switchable MRL, and an inert top layer, specifically for modelling and characterisation of thin coatings with unknown properties, with lipid bilayers or polymers being prime examples. An optimised substrate stack yields significantly different SLD profiles for polarised neutrons upon opposite magnetisations, effectively increasing the available data for obtaining the SLD profile for the unknown coating. The substrate assemblies are designed using the Holistic Optimization for Gaining Better Evidence from Neutrons (HOGBEN) software, employing a sensitivity analysis based on Fisher

information FI and correlation matrices enabling systematic evaluation of the information gain for different configurations The importance of this research lies in the potential to address the problem with limited beamtime access at neutron facilities by reducing the total measurement time required per sample without compromising obtained data quality The present study aims at optimising the design of solid substrates for polarised neutron reflectometry PNR experiments at the solid liquid interface for the structural investigation of soft matter biology samples The substrate assembly in this work consisted of a Si single crystal with its native oxide a ferromagnetic Fe reference layer and a SiO<sub>2</sub> capping layer By exploiting the magnetic contrast provided by the Fe layer and performing measurements in different ambients H<sub>2</sub>O D<sub>2</sub>O and SMW we obtained several reflectivity datasets from a single sample The measurements carried out with the POLREF instrument at the ISIS Neutron and Muon Source STFC Rutherford Appleton Laboratory UK provided detailed information on the SLD profile of a head tail head bilayer lipid structure Building on these results we initiated sensitivity studies using parameter correlation and FI to find the optimal substrate assembly designs that minimise measurement time while preserving data quality Our results demonstrate that sensitivity is significantly improved by jointly optimising the thicknesses of the Fe and the capping layer In particular we find that well chosen configurations of the MRL and capping layers can yield equivalent experimental information with up to a fivefold reduction in measurement time

*Surfaces and Interfaces for Biomaterials* Pankaj Vadgama, 2005-05-27 Given such problems as rejection the interface between an implant and its human host is a critical area in biomaterials *Surfaces and interfaces for biomaterials* summarises the wealth of research on understanding the surface properties of biomaterials and the way they interact with human tissue The first part of the book reviews the way biomaterial surfaces form Part Two discusses ways of monitoring and characterising surface structure and behaviour The final two parts of the book look at a range of in vitro and in vivo studies of the complex interactions between biomaterials and the body Chapters cover such topics as bone and tissue regeneration the role of interface interactions in biodegradable biomaterials microbial biofilm formation vascular tissue engineering and ways of modifying biomaterial surfaces to improve biocompatibility *Surfaces and interfaces for biomaterials* is a standard work on how to understand and control surface processes in ensuring biomaterials are used successfully in medicine Complete coverage on the fundamentals of surface structure and forming to biological and clinical outcomes Includes reviews of key surface analytical techniques Edited by a renowned expert and written by an international team of authors

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threshold densities by two orders of magnitude The thesis also advances the application of these compact novel lasers as highly sensitive detectors of explosive vapours demonstrating that rapid detection can be achieved when microporous polymers are used This work also demonstrates a prototype CMOS based microsystem sensor for explosive vapours exploiting a new detection approach

Tutorial Lectures in Electrochemical Engineering and Technology - II R. C. Alkire,1983 *Physics Briefs* ,1991 **Guide to Using WVASE 32** ,2008 **Scientific and Technical Aerospace Reports** ,1988 **A User's Guide to Ellipsometry** Harland G. Tompkins,2012-12-02 This book is specifically designed for the user who wishes expanded use of ellipsometry beyond the relatively limited number of turn key applications The book provides a concise discussion of theory and instrumentation before describing how to use optical parameters to determine material properties and optical parameters for inaccessible substrates and unknown films and how to measure extremely thin films The book also addresses polysilicon a material commonly used in the microelectronics industry and the effect of substrate roughness This book s concepts and applications are reinforced through the 14 case studies that illustrate specific applications of ellipsometry from the semiconductor industry as well as studies involving corrosion and oxide growth Allows the user to optimize turn key operation of ellipsometers and move beyond limited turn key applications Provides comprehensive discussion of the measurement of film thickness and optical constants in film Discusses the trajectories of the ellipsometric parameters  $\Delta$  and  $\Psi$  and how changes in the materials affect the parameter Includes 14 case studies to reinforce specific applications Includes three appendices for helpful references

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