Mapping of a thick transparent layer

Introduction

Thickness measurement of a layer is a frequent application of ellipsometry. To this end the observables Delta and Psi are simulated with the optical model of the sample. The model contains free parameters, i.e. layer thickness d, which is varied until the difference (mean square error) of measured and observed delta and psi is minimal. The optical model can be used to simulate delta and psi as a function of the thickness d. For a transparent layer (i.e. extinction k = 0, fig. 1) delta and psi are periodic. The period length depends on the angle of incidence and the wavelength. With a single pair of delta and psi the thickness can only be single correctly evaluated up to a multiple of the period length, which is typical 250 nm. In order to evaluate a unique thickness either an angle of incidence or a wavelength spectrum of delta or psi has to be fitted. The imaging ellipsometer EP^3-SW can record a delta map of the sample surface at one wavelength (fig.2) instead of single point measurements of delta usually done by non-imaging ellipsometers. The spectroscopic imaging ellipsometer EP^3-SE records a wavelength spectrum of several delta maps and thus evaluates a thickness map without

Sample

SiO_2-layer with appr. 1 µm thickness variation on a micro-structured silicon chip for fluorescence interference contrast (FLIC) microscopy [A.Lambacher and P.Fromherz,J.Opt.Soc.Am. B Vol.19, 1435 (2002)].

Instrumentation

Spectroscopic Imaging Ellipsometer EP^3-SE, auto-matic sample handling stage, 10x Objective

Task

Record a unique thickness map

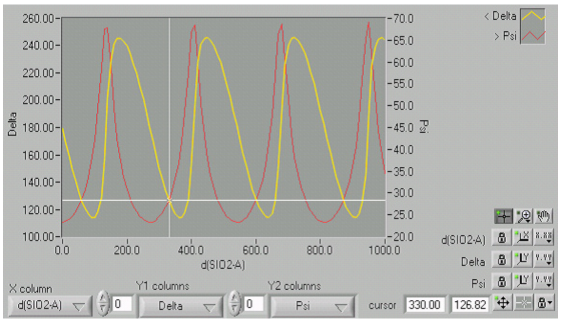

Fig. 1: Simulation: periodicity of delta and psi as a function of the thickness d(SiO2-A) [nm]

Steps of evaluation

1. On the same site of the sample record a set of delta maps at 400 nm, 488 nm, 532 nm (fig.2), 634 nm, 690 nm, 830 nm wavelength
2. Calculate the thickness map (fig.3) while fitting on the whole set of delta maps with the thickness as free parameter

Results

The stepwise increase of SiO_2-layer thickness from 0 to 1200 nm is recorded in one thickness map even though this thickness difference corresponds to several periods of delta and psi.

Acknowledgement

We would like to thank A. Lambacher, MPI for Biochemistry Munich, for supplying the sample.

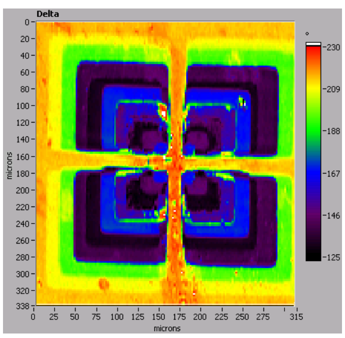

Fig. 2: Delta map, well focused by Nanofilm's unique image scanner, 532 nm wavelength, 55° angle of incidence, 4 µm lateral resolution

Nanofilm Surface Analysis
a division of Halcyonics GmbH
Anna-Vandenhoeck-Ring 5
37081 Goettingen
Tel.:+49(0)551/99960-0
Fax:+49(0)551/99960-10
email: info@nanofilm.de
www.nanofilm.de

Results

The stepwise increase of SiO_2-layer thickness from 0 to 1200 nm is recorded in one thickness map even though this thickness difference corresponds to several periods of delta and psi.

Acknowledgement

We would like to thank A. Lambacher, MPI for Biochemistry Munich, for supplying the sample.

Conclusion

Delta- and thickness-maps are unique features of the EP^{3}View software of all of Nanofilm's imaging ellipsometers EP^3. With the spectroscopic imaging ellipsometer EP^3-SE even series of delta maps can be evaluated to obtain one unique thickness map of a thick film. By contrast to scanning ellipsometry Nanofilm's imaging and mapping ellipsometry saves time of measurements and has higher lateral

Detail

How are delta-map and thickness-map generated by the EP^3?

The imaging ellipsometer EP^3 automatically generates a delta map in 30 seconds. To this end it records a series of life images with varying polarizer angle but constant analyzer angle. Consequently the intensity of each site of the mapped sample area is known as a function of the polarizer angle. This function is fitted and the polarizer angle p at the minimum of this function is found for each site.

A map of polarizer angles p is obtained. With where the signs represent the 4 different zones, the p-map is converted into a delt-map. Each delta value can be converted into a thickness with the optical model of the sample. In order to receive a unique thickness without ambiguity the set of delta values ("spectrum of delta") representing the same sample site at different wavelengths is fitted.

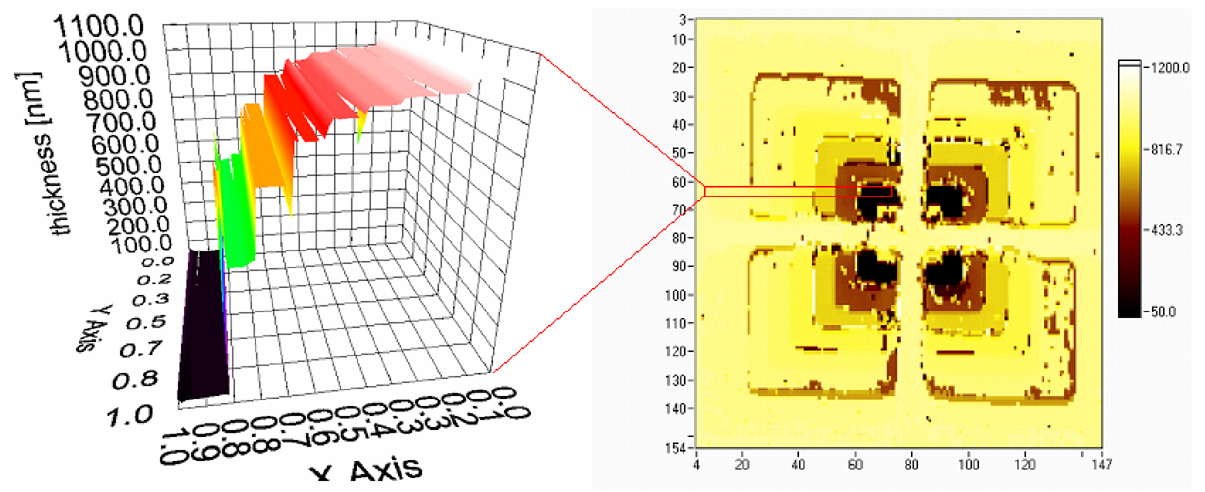

Fig. 3: Right: map of thickness [nm] (area: 0.3 mm x 0.3 mm), left: 3D-profile of marked area (red)

2008-05-26
Nanofilm Surface Analysis
a division of Halcyonics GmbH
Anna-Vandenhoeck-Ring 5
37081 Goettingen
Tel.:+49(0)551/99960-0
Fax:+49(0)551/99960-10
email: info@nanofilm.de
www.nanofilm.de