

Thickness Analysis of Natural Oxide Films using a MSV-5000 Microscopic Spectrophotometer

Introduction

The MSV-5000 series microscopic spectrophotometer is for transmission and reflection measurements in a wide wavelength range from the ultraviolet to near infrared. The built-in high resolution camera enables sample areas as small as 10 μm in diameter to be precisely measured and therefore is most suitable for samples having microstructure.

In this application note, a sample with silicon patterns 35 μm wide are lined up on a titanium substrate with 14 μm intervals. As silicon is oxidized in air, SiO_2 films are formed and the thickness of these films is analysed after obtaining the reflectance spectrum.



MSV-5200
UV-Visible/NIR Microscopic Spectrophotometer

Keywords

MSV-5200 microscopic spectrophotometer, VWML-791 Multi-Layer analysis program, Materials

Experimental

Measurement Conditions			
UV-Vis Bandwidth	5 nm	NIR Bandwidth	20 nm
Response	Slow	Scan Speed	100 nm/min
Data Interval	0.5 nm	Cassegrain Objective	16x
Incidence Angle	23°	IN/OUT Aperture	10 $\mu\text{m}\Phi$

An aluminum vapor-deposited mirror is used as a reference for the baseline measurement. The high-resolution camera is used to determine the sample area (Figure 1). The red spot illustrates the size and position of the detected light. The sample reflectance spectrum is measured and the absolute reflectance spectrum is calculated by multiplying the obtained relative reflectance by the absolute reflectance of the aluminum mirror.

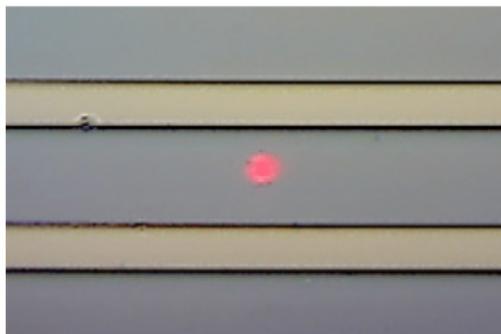


Figure 1. Observation point of measurement position.

Results

The measured absolute reflectance spectrum is shown in Figure 2. The MSV-5000 series adopts the confocal optical system that eliminates the influence of back side reflection when obtaining a sample measurement. Therefore, above 1100 nm where light passes through silicon, the spectrum is not influenced by back side reflection.

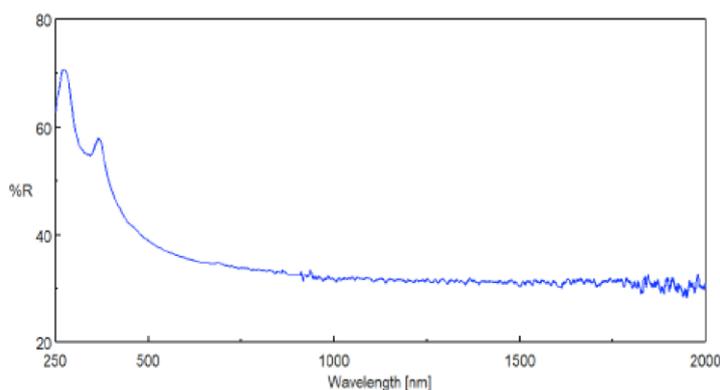


Figure 2. Absolute reflectance spectrum of SiO₂ film.

The results of fitting the absolute reflectance spectra using the *Multi-Layer Analysis* program is shown in Figure 3. The error between the measured and calculated spectrum was within 2% and the film thickness of SiO_2 was calculated to be 7.6 nm. The reflectance (R) is expressed using the refractive index of the film (n), extinction coefficient (k), the angle of incidence (Φ), wavelength (λ), and the film thickness (d). The optical constants of Si and SiO_2 were obtained from the literature values and the film thickness of SiO_2 is estimated using the *Multi-Layer Analysis* program which fits the calculated reflectance spectrum to the measured spectrum.

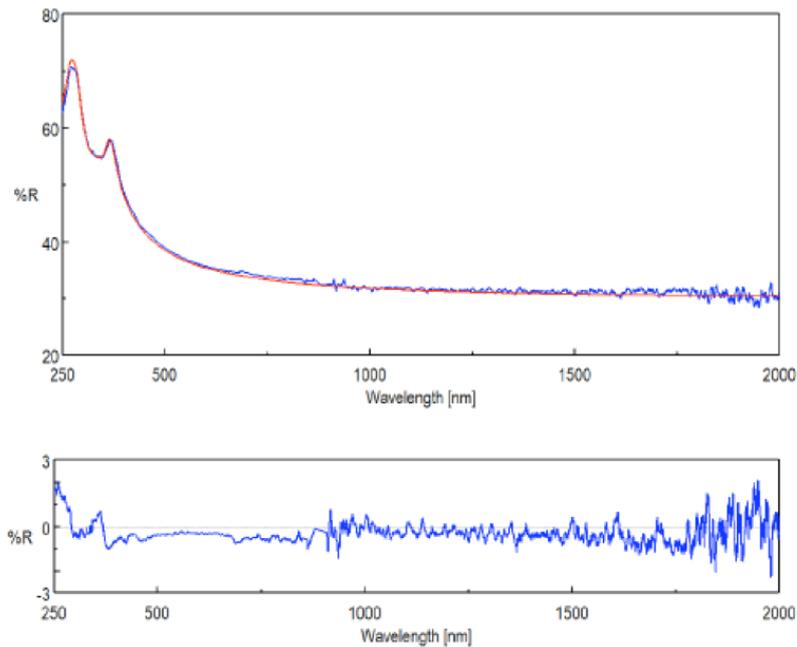


Figure 3. Top: Calculated (red) and measured (blue) reflectance spectrum of SiO_2 film.
Bottom: Error between the measured and calculated spectra.