Example of the measurement of a highly reflective material, a dielectric multi-layer mirror using absolute reflectance spectroscopy

Introduction

Dielectric multi-layer mirrors are laminated optics comprising of a combination of high refractive index and low refractive index materials. Using the interference effect, this mirror can provide extremely high reflectance (near 100%) in a specific wavelength range. (Fig. 1)

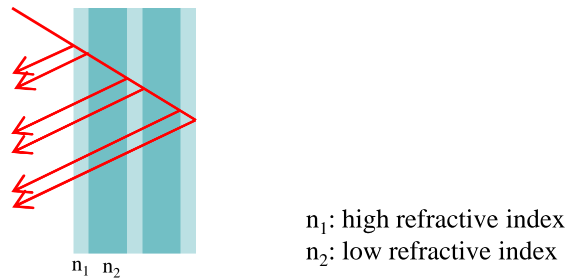

Fig.1 Diagram of the dielectric multi-layer mirror

This type of mirror is widely used in cameras, telescopes and optics for optical communication to reduce loss in light intensity. Therefore, in the quality control and R&D of dielectric multi-layer mirrors, it is very important to evaluate the reflectance with very high accuracy.

JASCO provides a high performance absolute reflectance measurement system using the V-700 series UV/Vis spectrophotometer with double-beam optical system, which has high photometric stability. The absolute reflectance system can perform measurement at arbitrary and user-selectable incident angles; this allows the measurement of dielectric multi-layer mirrors at designated incident angles.

As an example of high reflectance measurement using the JASCO absolute reflectance measurement system, this application note reports the results for a dielectric multi-layer mirror.

Keyword: V-700 UV-visible spectrophotometer, Dielectric multi-layer mirror, Absolute reflectance, High reflectance, Measurement repeatability

Sample

Dielectric multi-layer mirror

Measurement

(1) Dark measurement is performed with a light shielding plate.
(2) Baseline measurement is performed against air.
(3) Sample measurement is performed.

The procedure detailed above was repeated three times.

Measurement Condition

Bandwidth	5.0 nm
Scanning speed	20 nm/min
Response	3.84 sec
Data interval	1 nm
Incident angle	10 degree
Polarization	p-polarized light

Fig.2 Absolute reflectance measurement accessory

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Measurement result

Figure 3 shows an overlay of the absolute reflectance spectra of the dielectric multi-layer film mirror, and Figure 4 shows a zoomed view of the same spectra. As shown in the Figure 4, the measurement repeatability around 100%R is better than 0.1%R, which demonstrates that this system has very high measurement repeatability. Table 1 shows the comparison between the expected values and the measured values. The difference between the average of the measurement value and the expected value is better than 0.15%, which shows that this system has high accuracy and good correlation for reflectance measurement close to 100%R.

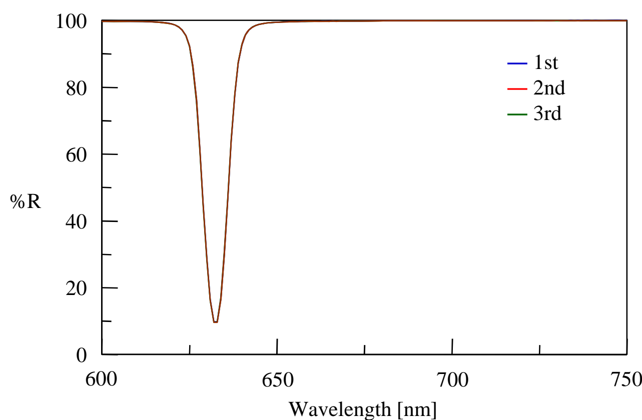

Fig. 3Absolute reflectance spectra of the dielectric multi-layer mirror

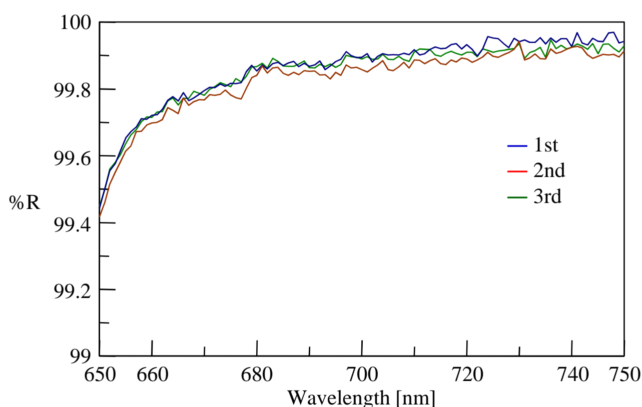

Fig. 4 Absolute reflectance spectra of the dielectric multi-layer mirror at around 100%R

Wavelength [nm]	Expected value [%R]	Measurement value [%R]			Average value [%R]	Standard variation	Variation coefficient [%]	Difference between expected and average
		1	2	3				
680	99.9914	99.8663	99.8537	99.8407	99.8536	0.013	0.013	–0.1378
700	99.9918	99.8892	99.8943	99.8578	99.8804	0.020	0.020	–0.1114
720	99.9839	99.9094	99.9316	99.8889	99.9100	0.021	0.021	–0.0739

Table1. Comparison of theoretical and measured values

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