

## Evaluation of antireflection film with using absolute reflectance measurement accessory

### Introduction

Antireflection film is widely used in many different products of various fields. For example, it is used for window and lens in visible region and also for near IR region laser diode in optical communication purpose and optical materials. The performance of antireflection film is getting higher recently, which is less than 0.1% reflectance level. And it is the one of reason for above expanded markets and fields.

This application note proved that JASCO Automated absolute reflectance measurement accessory can be applied to the reflectance measurement with less than 0.1%. For this proof statement, several measurement data are shown in below about film sample which has been designed less than 0.1% reflectance both in visible and near infrared regions.

**Keyword:** Antireflection film, AR coat, Absolute reflectance

### Sample

#### 1) Measurement for linearity

Visible region:  $\text{KMnO}_4$  solution (66.7, 133.3, 200.0, 266.7 mg/L)

Infrared region: ND filter A, ND filter B

#### 2) Reflectance measurement of antireflection film\*1)

AR coat VIS (430 - 600 nm)

AR coat NIR-1 (980 - 1140 nm)

AR coat NIR-2 (1320 - 1600 nm)

\*1 The base of antireflection film is quartz.

### Measurement

#### Measurement for linearity

##### 1.1 Visible region

(1) Dark measurement is carried out with setting the masking shield to the cell holder of Automated absolute reflectance measurement accessory.

(2) Baseline measurement is carried out with setting water set into the rectangular cell holder.

(3) Sample measurement is carried out with setting sample into the rectangular cell holder.

##### 1.2 Near infrared region

(1) Dark measurement is carried out with setting the masking shield to the sample holder of Automated absolute reflectance measurement accessory.

(2) Baseline measurement is carried out with air.

(3) Sample measurement is carried out with ND filter A set into the sample holder.

(4) Sample measurement is carried out with ND filter B, not parallel to ND filter A.

(5) Sample measurement is carried out with setting off ND filter A.

##### 2 Reflectance measurement of antireflection film

(1) Dark measurement is carried out with setting the masking shield to the sample holder of Automated absolute reflectance measurement accessory.

(2) Baseline measurement is carried out with air.

(3) Sample measurement is carried out with setting sample to sample holder.

## Result

### (1) Measurement for linearity

#### 1.1 Visible region

Figure 1 shows the absorption spectra of  $\text{KMnO}_4$  solution, and Figure 2 shows the calibration curve at 526 nm where is peak wavelength. As shown in Figure 2, in absorbance range from 1 to 4,  $R^2$  shows the high correlation (more than 0.999). This indicates that Automated absolute reflectance measurement accessory can provide absorbance up to 4, which means that transmittance and reflectance are obtained up to 0.01%.

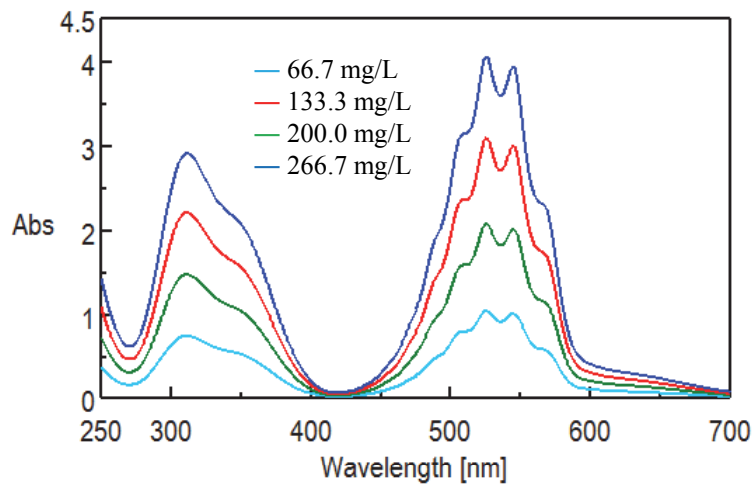


Fig.1 Absorbance spectrum  $\text{KMnO}_4$  solution

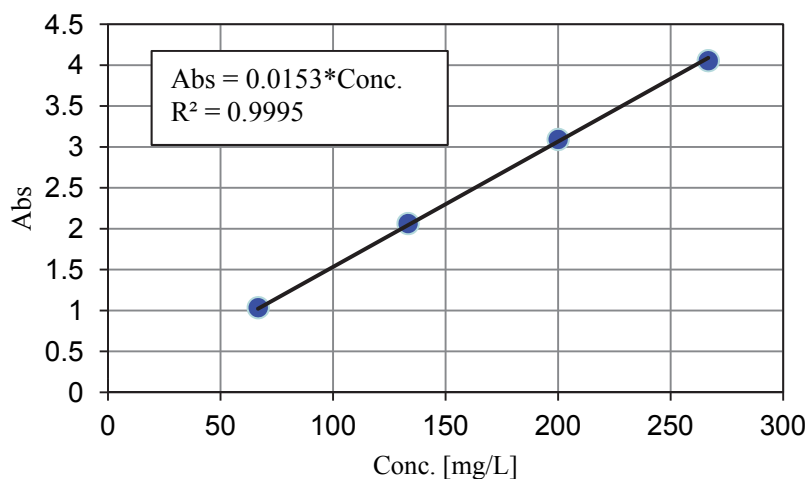


Fig.2 Calibration curve at 526 nm

## 1.2 Near infrared region

Figure 3 shows the absorption spectrum of ND filter. The spectrum of ND filter A and B agrees in that of sum of filters. This indicates that Automated absolute reflectance measurement accessory can provide absorbance up to 4, which means that transmittance and reflectance are obtained up to 0.01 %.

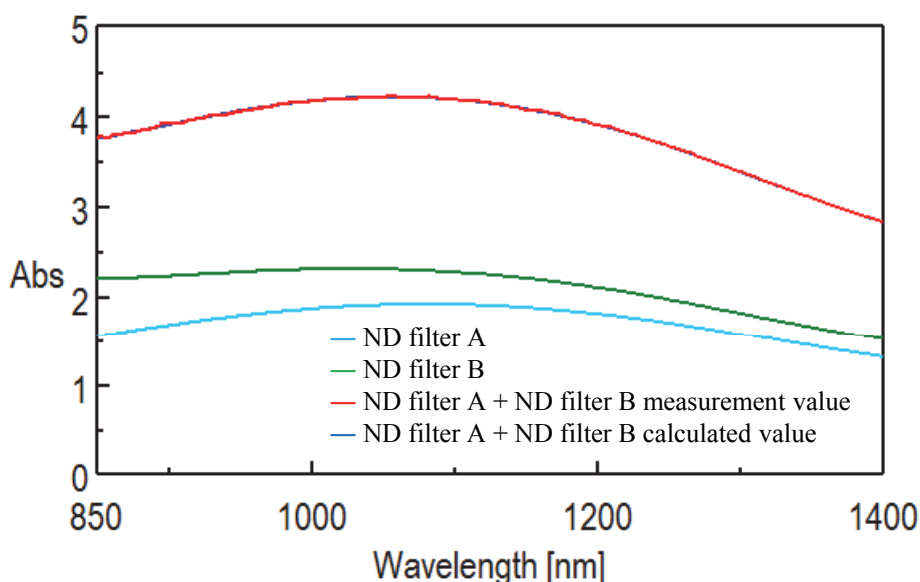


Fig.3 Absorbance spectra of ND filter

## 2) Reflectance measurement of antireflection film

Figure 4 shows the reflectance spectrum of antireflection film in visible region and Figure 5, 6 show in near infrared region. Table 1 shows the reflectance of the bottom peak.

As shown in Figure 4, 5, and 6, V-770/780 allow measurement with less than 0.1 % reflectance in the wavelength range from visible to near infrared.

V-770 and V-780 provides almost similar spectrum in terms of S/N ratio in the wavelength range from 980 nm to 1140 nm. But, in wavelength range from 1320 nm to 1600 nm, V-780 provides the more high-quality spectrum with high S/N ratio due to the difference of installed detector. V-770 equips the PbS detector which has high sensitivity in the wide wavelength range. On the other hand V-780 equips the InGaAs detector which has more high sensitivity.

Thus, this means V-770 is suitable for measurement with wide wavelength range and V-780 is suitable for high sensitivity measurement.

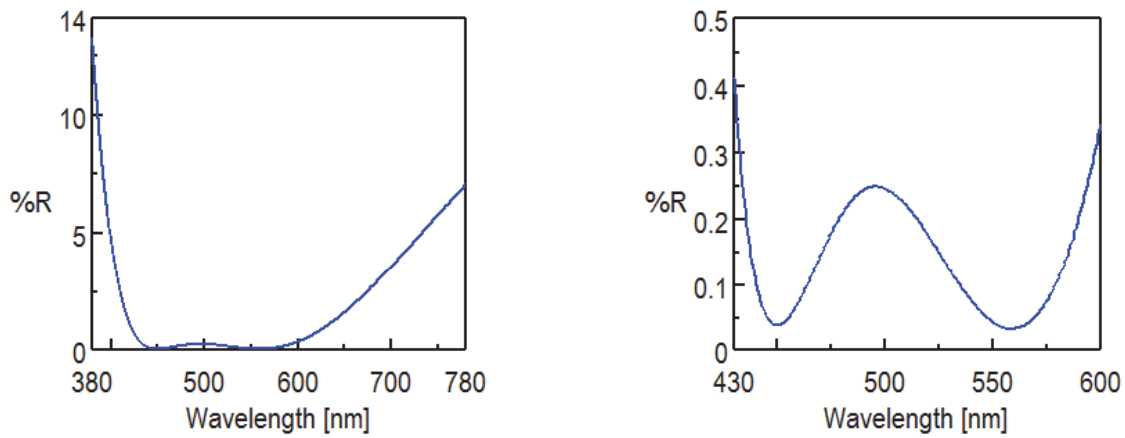


Fig.4 Reflectance spectrum of AR coat VIS

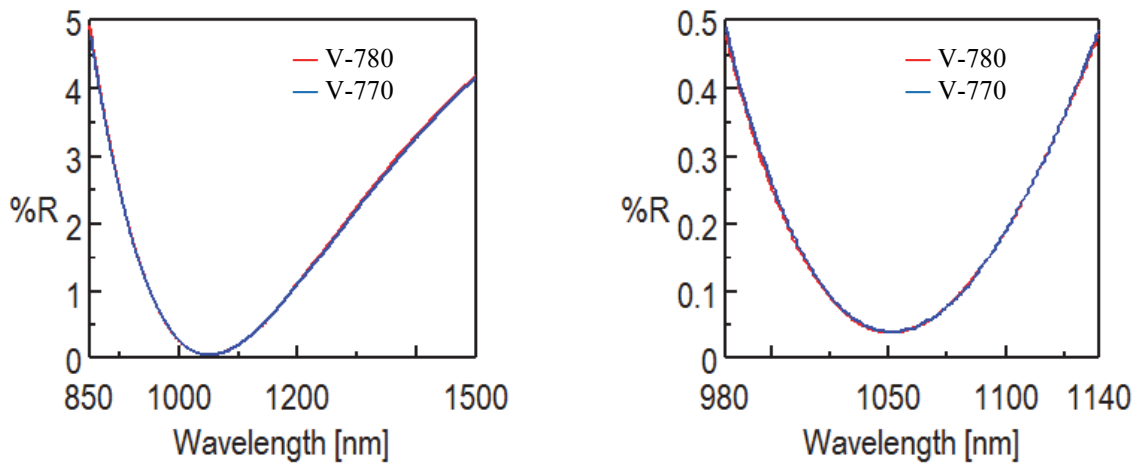


Fig.5 Reflectance spectrum of AR coat in visible region NIR-1

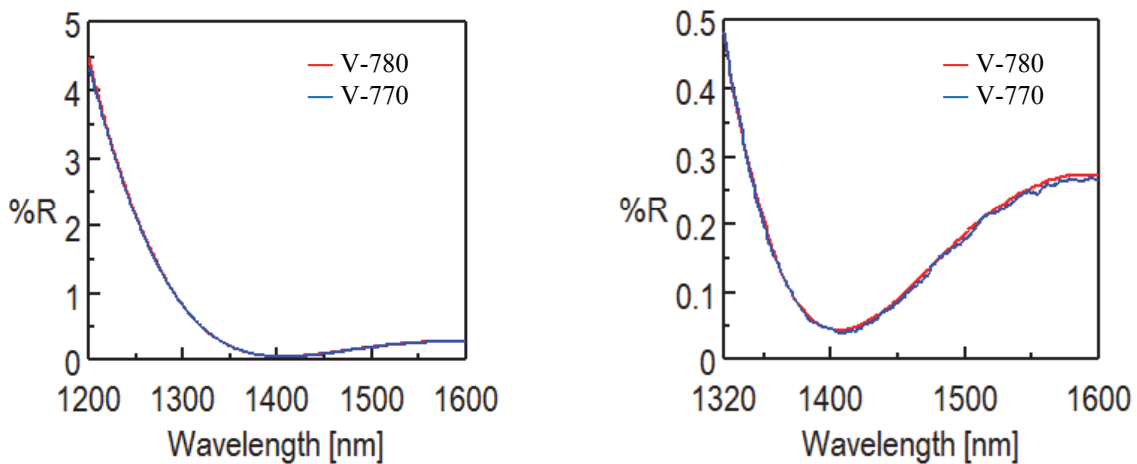


Fig.6 Reflectance spectrum of AR coat in visible region NIR-2

Table 1 Reflectance of bottom peak in reflectance spectrum

AR coat VIS		AR coat NIR-1		AR coat NIR-2				
Wavelength [nm]	Reflectance [%]	Wavelength [nm]	Reflectance [%]	Wavelength [nm]	Reflectance [%]			
V-770	450.5	0.03681	V-770	1049	0.03655	V-770	1406	0.03703
	558.0	0.03144	V-780	1049	0.03655	V-780	1406	0.04235

## Measurement parameters

### 1 Measurement for linearity

#### 1.1 Visible

UV/Vis band width	L5.0 nm	Scan speed	100 nm/min
UV/Vis response	3.84 sec	Data interval	1 nm

#### 1.2 Near-infrared

NIR band width	40.0 nm	Scan speed	100 nm/min
NIR response	3.84 sec	Data interval	1 nm

### 2 Reflectance measurement of antireflection film

#### AR coat VIS

UV/Vis band width	L5.0 nm	Scan speed	200 nm/min
UV/Vis response	0.96 sec	Data interval	0.5 nm
Incident angle	5°	Polarization	N-polarized light

#### AR coat NIR-1/NIR-2

NIR band width	40 nm (V-770)/ 10.0 nm (V-780)		
Scan speed	100 nm/min	NIR response	3.84 sec
Data interval	1 nm	Incident angle	5°
Polarization	N-polarized light		