Reflection and Transmission Measurements of Chlorine Content Color Wheel

Background

The customer supplied us with a special wheel used for chlorine content measurements. The provided sample has nine windows of varying shades of yellow, with a clear center window for reference, as shown in *Figure 1*. The window numbering sequence can be seen on the perimeter of the sample in permanent marker; the sequence is from 1 to 9 in order of yellow intensity (9 = most yellow). Transmission and reflection measurements were performed for each window in the sample in order to provide accurate spectrometric data for different film characteristics.

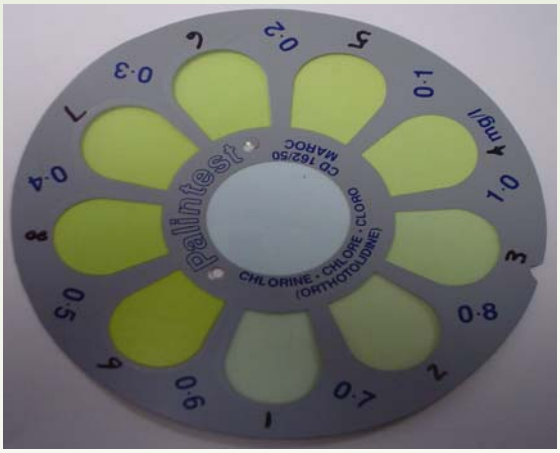

Figure 1. Chlorine Content Color Wheel

Experimental Procedure

We analyzed the wheel's films using a USB4000 UV/VIS Spectrometer, an LS-1 tungsten-halogen light source with BG34 lens installed, and SpectraSuite Spectrometer Operating Software. For the reflection measurements, a reflection probe (R400-7-VIS/NIR), reflection stage (STAGE), and the PTFE diffuse reflectance standard (WS-1) were utilized. The overall distance from the tip of the reflection probe ferrule to the sample surface was around 3-mm. *Figure 2* shows a photograph of the reflection experimental setup. Given the transparency of the windows, we used the WS-1 reflection standard as background for all reflection measurements. *Figure* 3 shows the sample mounted on the WS-1 in the reflection stage. The reference spectrum for the reflection measurements was the clear center window with the WS-1 background.

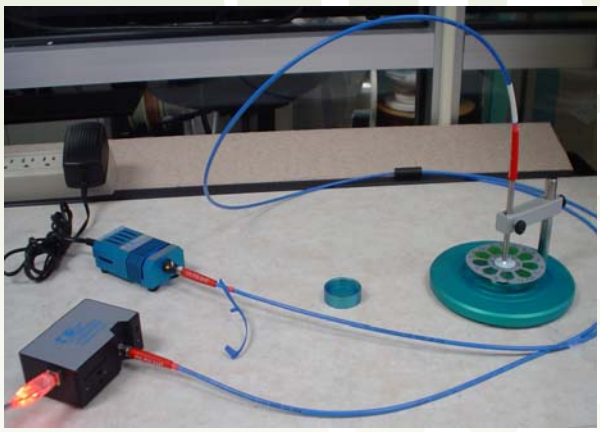

Figure 2. Reflection experimental setup

The transmission setup included an adjustable collimation lens holder (74-ACH), two collimating lenses (74-UV) and two premium grade 300-micron fibers (QP400-1-UV/VIS) as shown in *Figure 4*, utilizing the same light source and spectrometer. The transmission measurements were conducted using two different references. In the first experiment, the clear center window was mounted in the transmission stage and a reference spectrum was captured. All of the subsequent window spectra are referenced to the central window spectrum. In the second experiment we removed the sample from the optical path and obtained the reference spectrum. We captured spectra from all nine windows and the clear central window with respect to the free optical path reference.

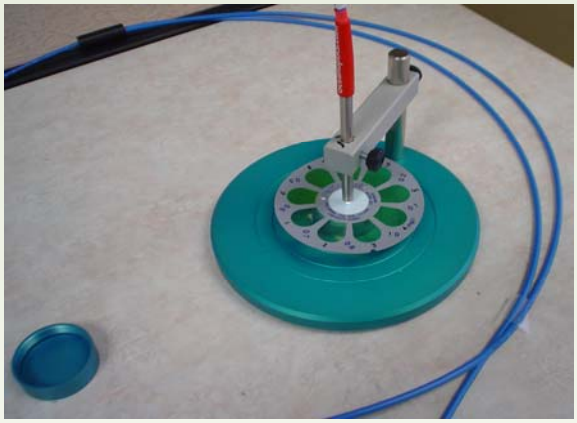

Figure 3. Sample shown with WS-1 background

Results

The reflection and transmission results for each window in the chlorine content color wheel are shown in *Figure 5 – Figure* 7. A summary of the measurement parameters used in SpectraSuite software is presented in *Table 1*.

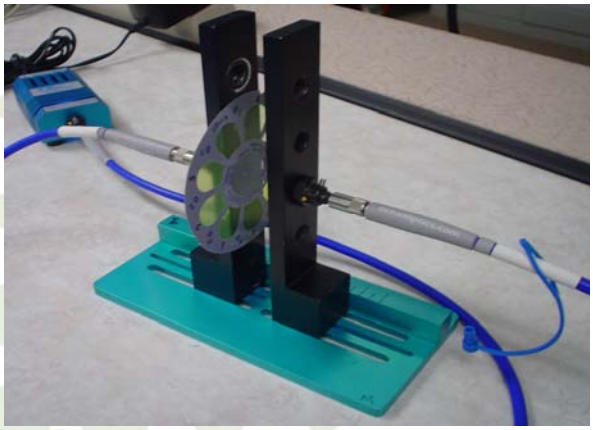

Figure 4. Sample shown in transmission stage

Table 1: Measurement Parameters

Parameter	Reflection	Transmission
Integration Time	170 ms	30 ms
Scans to Average	3	10
Boxcar	3	3
Correct for Electrical Dark	No	No
Correct for Nonlinearity	No	No
Correct for Stray Light	No	No

The following results are color-coded as labeled in the figure legends. All figures employ the same color-coding (e.g., window one is blue in all diagrams). The measurement parameters from Table 1 are also visible in the left frame of the figures.

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There is good correlation between the reflection data and transmission data (using the center window as reference). Based on the setup of the reflection experiment, we would expect similar spectral shape to the transmission data because of the PTFE diffuse reflection standard background. Essentially, the light is transmitted through each window, reflects off the 99% diffuse reflection standard, the reflection is transmitted back through the window and is read by the spectrometer. Therefore, the spectral shapes should be essentially the same.

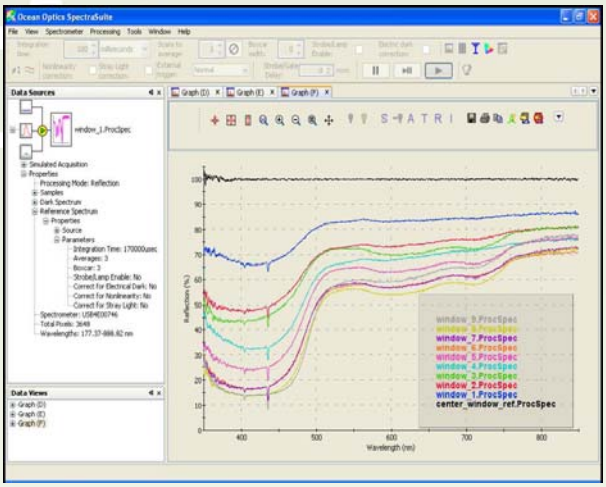

Figure 5. Reflection experiments results

From the comparison of the two sets of transmission data, it is clear that using the results obtained with the clear center window spectrum as a reference would be most advantageous for classifying the subtle differences in the sample windows. This is primarily due to the nature of the clear center window in the region from 350 – 500 nm. The center window spectrum is actually concave down (negative second derivative) over that region, which actually enhances the light source signal over that region. This region best classifies the sample windows.

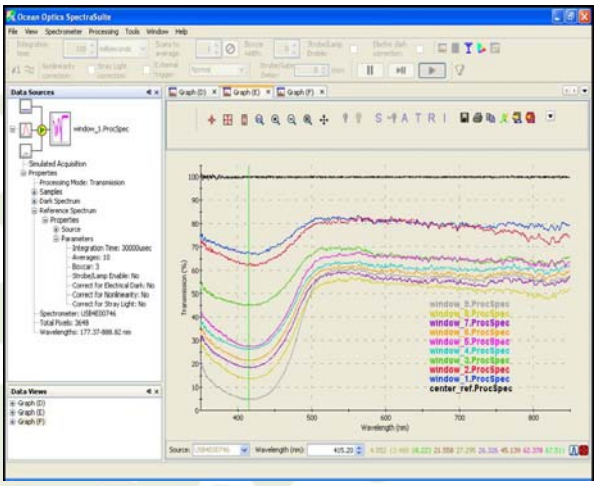

Figure 6. Transmission data with center window as reference

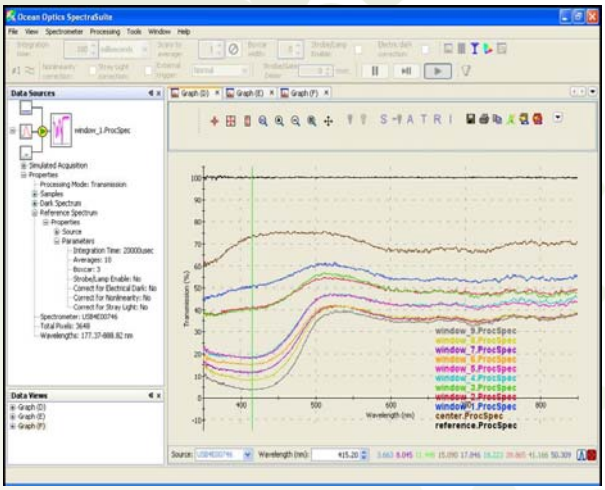

Figure 7. Transmission data with no sample in optical path as reference

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Featured System	Preferred System	High Flexibility System
USB4000 UV/VIS Spectrometer http://www.oceanoptics.com/products/usb4000uvvis.asp	**USB4000 UV/VIS** Spectrometer http://www.oceanoptics.com/products/usb4000uvvis.asp	**USB4000 UV/VIS** Spectrometer http://www.oceanoptics.com/products/usb4000uvvis.asp
LS-1 Light Source http://www.oceanoptics.com/products/ls1.asp	**HL-2000** Light Source. http://www.oceanoptics.com/products/hl2000.asp	**DH2000-BAL** Light Source. http://www.oceanoptics.com/products/hl2000.asp
QR400-7-UV-VIS Reflection Probe http://www.oceanoptics.com/products/reflectionprobesstandard.asp	**QR600-7-UV 125-F** Reflection Probe http://www.oceanoptics.com/products/reflectionprobesstandard.asp	**QR600-7-SR-125-F** Reflection Probe http://www.oceanoptics.com/products/reflectionprobesstandard.asp
Reflection Probe **STAGE** **http://www.oceanoptics.com/products/stage.asp**	Reflection Probe **STAGE** **http://www.oceanoptics.com/products/stage.asp**	Reflection Probe **STAGE** **http://www.oceanoptics.com/products/stage.asp**
WS-1 Diffuse Reflectance Standard **http://www.oceanoptics.com/products/ws1diffrefstan.asp**	**WS-1** Diffuse Reflectance Standard **http://www.oceanoptics.com/products/ws1diffrefstan.asp**	**WS-1** Diffuse Reflectance Standard **http://www.oceanoptics.com/products/ws1diffrefstan.asp**
74-ACH Adjustable Collimating Lens Holder **http://www.oceanoptics.com/products/74ach.asp**	**74-ACH** Adjustable Collimating Lens Holder **http://www.oceanoptics.com/products/74ach.asp**	**74-ACH** Adjustable Collimating Lens Holder **http://www.oceanoptics.com/products/74ach.asp**
74-UV Collimating Lenses http://www.oceanoptics.com/products/74series.asp	**74-UV** Collimating Lenses http://www.oceanoptics.com/products/74series.asp	**74-UV** Collimating Lenses http://www.oceanoptics.com/products/74series.asp
SPECTRASUITE Spectrometer Operating Software http://www.oceanoptics.com/products/spectrasuite.asp	**SPECTRASUITE** Spectrometer Operating Software http://www.oceanoptics.com/products/spectrasuite.asp	**SPECTRASUITE** Spectrometer Operating Software http://www.oceanoptics.com/products/spectrasuite.asp
~ $ 6,750 US Dollars	**~ $ 7,150 US Dollars**	**~ $ 10,500 US Dollars**

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Related References

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