Ocean Optics

Application Note

Keywords

- Aluminum alloy
- Coatings
- Thin film deposition

Techniques

- Specular reflection
- UV-Vis spectroscopy

Applications

- Feasibility testing
- Quality control
- Process monitoring

Reflection of Aluminum Alloys for Automotive Wheels

Written by Ocean Optics Staff

In this application note, we evaluated a color shift that occurred with deposition of a thin film of aluminum chrome alloy to a cured, powder-coated wheel. The alloy had been applied to the wheel surface via direct current (DC) sputtering, a deposition process used to coat surfaces with different materials. The objective of the experiment was to investigate the color shift as a function of deposition time, both before and after clear coating with an acrylic powder for UV protection.

Background

The texture of surfaces causes them to reflect light differently. Very smooth surfaces like mirrors exhibit specular reflection, in which all rays in the incident beam reflect in the same direction (angle of reflection = angle of incidence). Rough or matte surfaces exhibit diffuse reflection, in which the rays of the incident beam are scattered in all directions. The typical surface is in-between, having both specular and diffuse components.

Reflectance measurements express the amount of light reflected from a surface as a percentage of the light used for illumination. Since it can be technically challenging to collect and measure the total light incident on a surface, reflectivity is generally measured relative to a standard reference. The standard chosen should be similar in reflectivity to the sample in order to yield similar signal levels during measurement and achieve the best signal to noise performance. Our STAN-SSH high reflectivity specular reference standard is a mirrored, fused silica standard that works well when measuring very shiny surfaces such as chrome wheels.

Experimental Conditions

Using the STAN-SSH as our reference, we measured the specular reflection of a common location on the spoke of each sample wheel (see Table 1). Our setup comprised a USB4000-UV-VIS spectrometer (preconfigured for 200-850 nm, with a 25 µm entrance slit and order-sorting filter) with a balanced deuterium-halogen light source and a premium-grade 400 µm reflection probe (6-around-1 fiber bundle to ensure parallel orientation of the fibers). Measurements were made at 24 milliseconds integration time, with 15 scans to average and boxcar smoothing set to 3.

Table 1

Sample	Deposition Time	UV Coating
Sample No. 1	30 seconds	Yes
Sample No. 2	30 seconds	No
Sample No. 3	60 seconds	Yes
Sample No. 4	60 seconds	No
Sample No. 5	90 seconds	Yes
Sample No. 6	90 seconds	No

Results

The presence of the UV coating is clearly seen in samples 1, 3 and 5 as indicated by the cutoff in the reflectance at ~380 nm (Figure 1). Furthermore, the maximum deviation between the UV-coated samples occurs at approximately 510 nm.

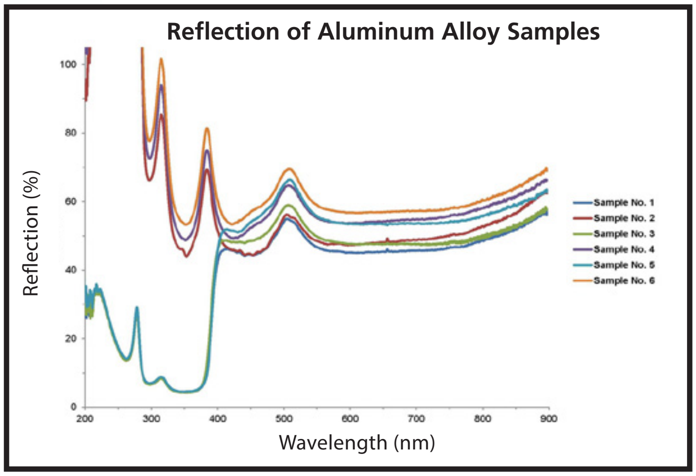

Figure 1: Specular reflection of aluminum alloy samples reveals spectral differences among samples with and without a UV-protection clear coat.

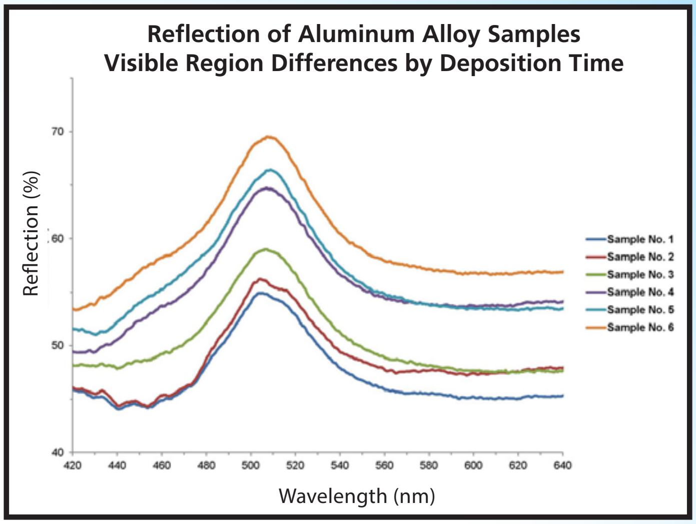

Figure 2: The lengthier the time of coating deposition for each sample, the greater its reflectivity. UV-coated samples showed greater difference in the visible portion of the spectrum.

When we observe this peak in the reflectance more closely, as shown in Figure 2, it is evident that the percent reflectance is proportional to the deposition time. For the uncoated samples, the range from 300-400 nm exhibits two peaks (Figure 3), both of which suggest that the percent reflectance is proportional to the deposition time.

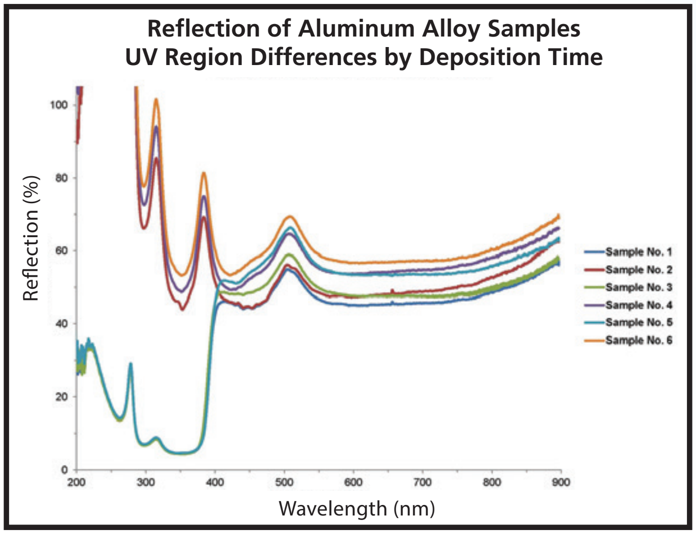

Figure 3: Differences in sample reflectivity for uncoated samples were influenced by coating deposition time. Uncoated samples showed greater difference in the UV portion of the spectrum.

Conclusion

Reflectance measurements can be made to determine the color of an object or to examine differences between objects for sorting, quality control or scientific study. The objects to be measured can be as diverse as automotive parts, paint, coffee beans and lizards, making it challenging to choose the right system for a specific sample.

As our application note demonstrated, by using the appropriate spectrometer configuration and sampling methodology, researchers and QC professionals can exploit modular spectroscopy for both qualitative and quantitative measurement of surface coatings and thin film deposits.

Contact us today for more information on setting up your spectroscopy system from Ocean Optics.