HARRICK SCIENTIFIC PRODUCTS

No. 40608

applications note

THE EFFECT OF SURFACE UNIFORMITY ON THE SPECULAR REFLECTANCE FROM CARBON-FILLED COATINGS

Figure 1. The Seagull™.

Figure 2. The Video Meridain™.

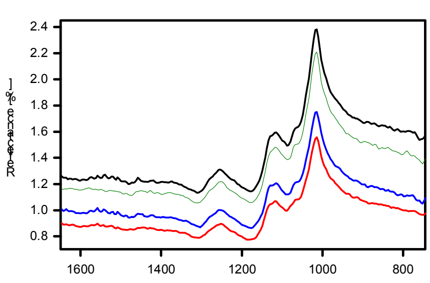

Figure 3. The 60° specular reflectance from two samples recorded with the Seagull.

INTRODUCTION

Carbon-filled coatings are frequently applied to materials to reduce their infrared and visible reflectivity. Specular reflectance is frequently the method of choice for examining the reflectivity of these coatings. However, these coatings are not always smooth and this can produce anomalies that complicate interpretation of the results.

This applications note demonstrates the problem using a routine method used to check the coatings and then explores the effect of coating texture and uniformity on the results.

EXPERIMENTAL

The samples examined were pieces of sheet metal coated by Duracon™ Optical Black Coating from American IMEX Corporation. Several samples were prepared in a similar fashion and then used for this study.

These samples are routinely examined using the Seagull™ variable angle reflectance accessory (Figure 1) that utilizes a 1:1 imaging system. The Seagull™ was set for its specular reflectance mode at an incident angle of 60º.

For a more detailed inspection of the surface, the VideoMeridian™ microsampler (Figure 2) was used. The VideoMeridian™ features a six times beam condenser and a fixed 45º incident angle. It was configured for specular reflectance and its built-in video camera was adjusted so the sample was in focus. The sample was randomly scanned and digital images were acquired, using the MicroSnap™ software, for each position along with the spectra.

Both the Seagull™ and the VideoMeridian™ were used in conjunction with a commercial FT-IR spectrometer and the data was collected over the mid-infrared region at 8 cm^{-1} resolution and signal averaged over 32 scans.

RESULTS AND DISCUSSION

The results from the routine analysis of two samples using the Seagull™ are shown in Figure 3. Two measurements were taken from each sample and the sample was repositioned between measurements. While it is clear that little of the incident radiation is reflected, the reflectance does differ as a function of the sample and its position. This difference is evident both in the base level of reflectivity and in the peak intensity.

The Effect of Surface Uniformity on the Specular Reflectance from Carbon-Filled Coatings

Since the samples were prepared in the same fashion and the samples have some texture, it is possible that the coating is not uniform in either texture or coverage. This non-uniformity could be altering the reflectance from the surface.

To examine this phenomenon in more detail, the surface of one of the samples was randomly scanned and examined using the VideoMeridian™. The resulting spectra are shown in Figure 4 and the corresponding images are presented in Table 1.

Comparison of the band intensities in Figures 3 and 4 shows that the magnitude of the intensity fluctuations is approximately six times smaller with the Seagull than with the VideoMeridian™. This is expected given the differences in the sampled areas between the two accessories.

From Table 1, it is clear that the samples show differences in overall texture. In addition, several sections (d and f in Figure 4) appear to have micro-holes in the coating. The differences in the overall brightness of the visual image are loosely correlated to the band intensity differences shown in Figure 4. It is possible that a direct correlation between the sample texture and the infrared band intensity could be drawn if infrared illuminated portion of the visual image could be distinctly analyzed.

However, the 'holes' in the coating may cause non-linear effects. Since the spectrum is significantly different for a thin film. Figure 5 shows the spectrum of a corner of the sample which is only partly coated. This spectrum shows the transmission-like characteristics of a thin film on a metallic substrate rather than the dispersive characteristics typical of specular reflectance.

CONCLUSION

As seen from the data presented herein, the Video Meridian™ microsampler can be used to examine surface inhomogeneities that are a few millimeters in size both visually and by infrared spectroscopy. Infrared spectroscopy effectively integrates over the illuminated area. However, the effect of surface inhomogeneities can be detected in the resulting spectra for both small and large sampling areas.

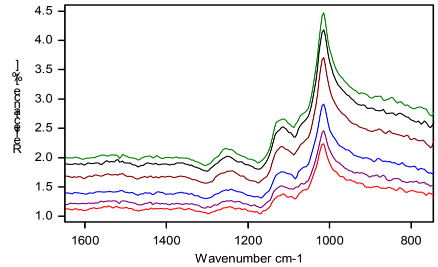

Figure 4. The 45° specular reflectance of sampling positions a through f (top to bottom) recorded with the VideoMeridian™.

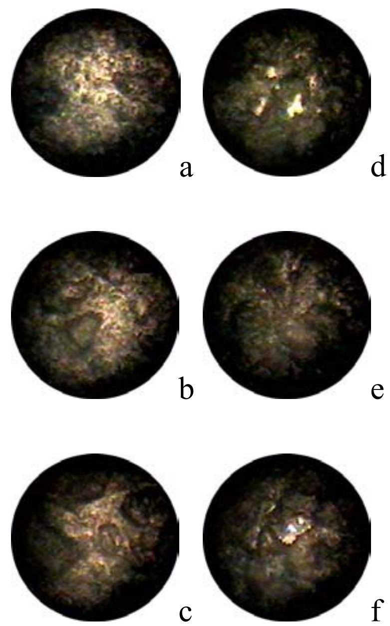

Table 1. Photographs of the sections examined in Figure 4.

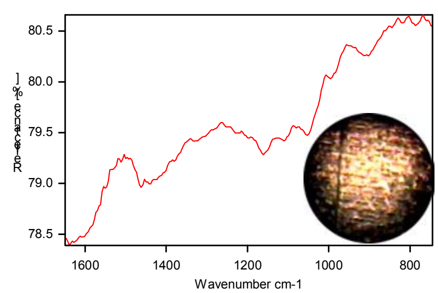

Figure 5. The 45° specular reflectance and photograph of a lightly coated section of the sample.

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