HARRICK SCIENTIFIC PRODUCTS

No. 21143

ANALYSIS OF WEAR SCRATCHES ON METAL SURFACES USING DIAMOND ATR

Figure 1. Samples 1 and 2 from left to right.

Figure 2. The VideoMVP diamond ATR accessory.

INTRODUCTION

Tribology – the study of friction, wear and lubrication - is important in mechanical, electromechanical and biological systems. Changes in materials due to abrasion, friction, lubrication, erosion and corrosion result in failures of the moving components during use.

Typically these effects are minimized by careful surface finish design and lubrication. The lifetime of the components can also be extended by recycling and refinishing surfaces when needed.

By examining worn surfaces, better methods can be developed to prevent wear. This applications note uses infrared spectroscopy to study tribology changes in steel and steel with a carbon based coatings that have been subject to wear.

EXPERIMENTAL

The samples investigated were polished steel discs, 28 mm in diameter by 8 mm thick and defects thereon (see Figure 1). Sample 2, the darker sample, has a carbon based coating on top to enhance the surface hardness. The three samples were lubricated, tested and then cleaned with n-heptane, leaving chemisorbed species in the wear scratches on the surface.

The spectra of the discs were measured on a FTIR spectrometer equipped with the Harrick VideoMVP™ (see Figure 2) with its optional Force Sensor. The background spectrum was collected from the clean ATR crystal. Then the sample was placed, face down, on the diamond crystal and positioned over the area of interest using the image on the display. The pressure applicator was lowered to apply ~240N of force to compress the sample against the crystal. The spectrum and image were then recorded. All spectra were collected from 4000 to 400 cm^{-1} using 32 scans at 8 cm^{-1} resolution.

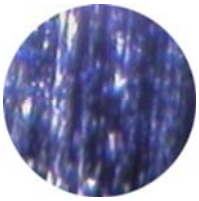
RESULTS AND DISCUSSION

Figures 3 and 4 show spectra measured from a section with wear scratches in comparison to a shiny smooth section, along with photographs of the areas of each sample that were examined. The worn areas of sample 1 show slightly more intense bands in the 2800-3000 cm^{-1} region relative to the shiny areas. This indicates that an organic residue or chemisorbed species remained in the worn area. The wear scratches in both of these samples have distinct bands at 1174 cm^{-1}, 956 cm^{-1} and 609 cm^{-1}, so it is likely both have worn in a similar fashion or were lubricated with the same material.

applications note

Analysis of Wear Scratches on Metal Surfaces Using Diamond ATR

a. Photograph of an area on sample 1 area with minimal wear. Shown in red in the spectra below.



b. Photograph of a scratched section of sample 1. Shown in blue in the spectra below.

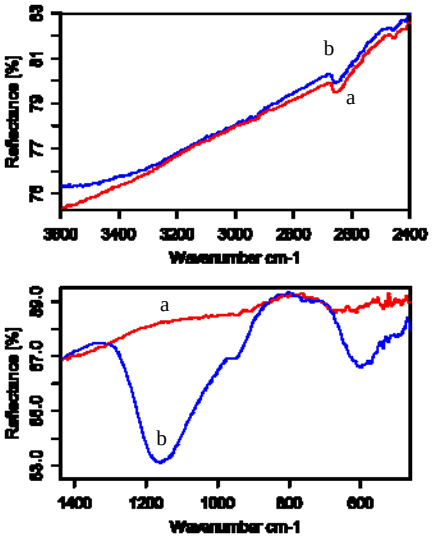


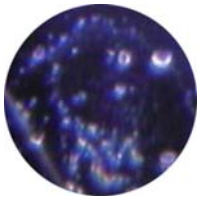
Figure 3. Photographs and ATR Spectra of Sample 1.

The spectrum of a relatedly unworn section of sample 2 is distinctly different from that of samples 1. This is either due to the carbon-based coating on it or the interaction of the coating with the lubricant. The wear scratches show additional changes in the infrared spectrum at 3320 cm^{-1} and 1045 cm^{-1}.

Note that the change in band intensities for the wear scratches is much smaller for the sample with the carbon-like coating, indicating that the coating is protecting the component from wear.

More detailed analysis could be used to identify the chemisorbed species. The results present here clearly show that diamond ATR can be used to examine tribology materials. The viewing capabilities and small sampling area of the VideoMVP allow for inspection of the wear scratches in comparison to the unworn areas.

a. Photograph of an area on sample 2 area with minimal wear. Shown in red in the spectra below.



b. Photograph of a scratched section of sample 2. Shown in blue in the spectra below.

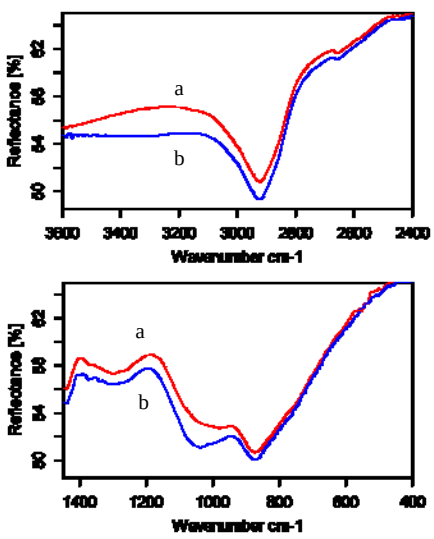


Figure 4. Photographs and ATR Spectra of Sample 2.

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