HARRICK SCIENTIFIC PRODUCTS

No. 40302

INFRARED DETECTION OF FILMS ON ROUGH SURFACES: AN ATR STUDY OF HARDWOOD FLOORING

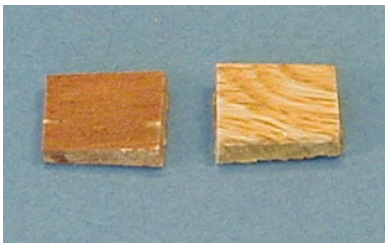

Figure 1. Samples A (left) and B (right).

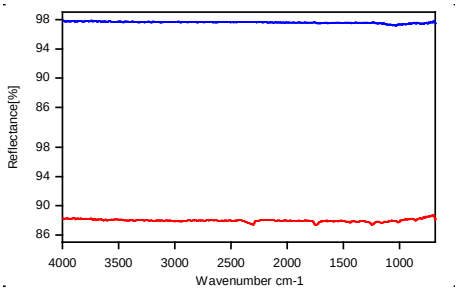

Figure 2. ATR Spectra of Sample A (blue) and B (red) Recorded with the Horizon.

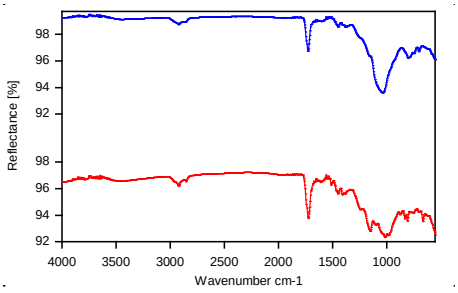

Figure 3. ATR Spectra of Sample A (blue) and B (red) Recorded with the FastIR.

INTRODUCTION

The flooring industry is continually improving flooring materials to make them more durable while limiting the degree of discoloration over time. Multiple reflection ATR infrared spectroscopy is frequently used to examine the man-made flooring materials, like vinyl, but presents problems with the natural flooring materials like the hardwoods. The hardwoods are not flexible enough to obtain good contact over the large area of the ATR crystal, and this makes it difficult to examine the base urethane and additives in the coating.

This applications note investigates the effectiveness of three different ATR methods - multiple reflection ATR, single reflection ATR and micro-ATR for analyzing this type of sample.

EXPERIMENTAL

Two samples of coated hardwood flooring were examined. Both samples were rectangles, approximately 0.5”x0.5”x0.25”, with optically thick coatings. Sample A was stained mahogany and Sample B had natural-colored finish (see Figure 1).

Each sample was examined using three different ATR accessories (see Table 1). All three accessories featured a nominal incident angle of 45º and a crystal with a refractive index of 2.4. The samples were compressed against the crystal using the maximum pressure delivered by the pressure applicator without damaging the crystal. All spectra were collected with the accessory installed in a commercial FT-IR spectrometer. The spectrometer was set for 32 scans at 8 cm^{-1} resolution and used a DTGS detector. Its gain was adjusted to maximize the energy on the detector for each accessory.

Table 1: The ATR Accessories Utilized

Type of Accessory	Name	ATR Material	Exposed Sampling Surface (approx. size)
Multiple Reflection ATR	Horizon™	ZnSe	50 x 10 mm
Single Reflection ATR	FastIR™	ZnSe	16 mm diameter
Micro-Single Reflection ATR	Meridian™	Diamond	500 µm diameter

RESULTS AND DISCUSSION

Figure 2 shows the multiple reflection ATR spectra of the two pieces of coated wood. The spectrum of sample A shows no bands, while that of sample B shows extremely weak bands. Since the coatings typically used on hardwood flooring are organic-based, infrared transitions are expected. However, the surface of the samples is somewhat rough and the sampling surface is fairly large, so the lack of clear

applications note

infrared bands may be due to insufficient contact between the sample and the ATR crystal

Figures 3 and 4 show spectra collected using accessories with smaller sampling areas. All the spectra show distinct infrared bands, as expected from the coatings on the flooring. Comparison of these spectra reveals much stronger bands in that obtained using the Meridian, despite the higher signal-to-noise ratio of the FastIR. Hence the Meridian, with its smaller spot size, provides the best overall spectral contrast. Also note the Meridian spectra (Figure 4) contain bands that are better resolved that those in Figure 3. This may simply be an attributed to better contact, but it could also be a localized difference in the sample. Since the sampled area of the Meridian is so much smaller than that of the FastIR, the sampling by the Meridian may show inhomogeneities in the sample that were averaged over into the larger area sampled by the FastIR.

High quality infrared spectra can be collected from these rough surface samples using single reflection ATR. Furthermore, by comparing the two spectra shown in Figure 4, it is clear that the two stains are chemically different. Sample A has a much stronger band at 1070 cm^{-1}. It is likely that this band is due to SiO2 since SiO2 is commonly used as an additive to hardwood flooring finishes to improve their durability.

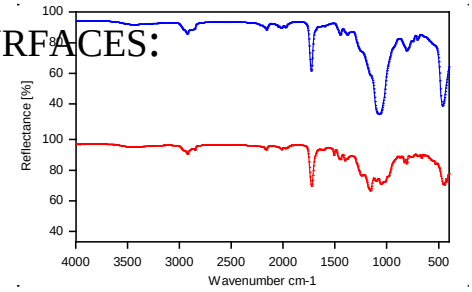

Figure 4. ATR Spectra of Sample A (blue) and B (red) Recorded by the Meridian SplitPea.

SUMMARY

Single reflection micro-ATR is by far the most effective method of investigating rough surface samples, such as coatings on hardwood flooring. Some information can be obtained from this type of samples with traditional single reflection ATR, but multiple reflection ATR is ineffective due to inadequate contact between the sample and ATR crystal.

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