Anatomy of a Pen: A Diamond ATR Study of the Components of a Blue Pen

Figure 1. The DiaMaxATR.

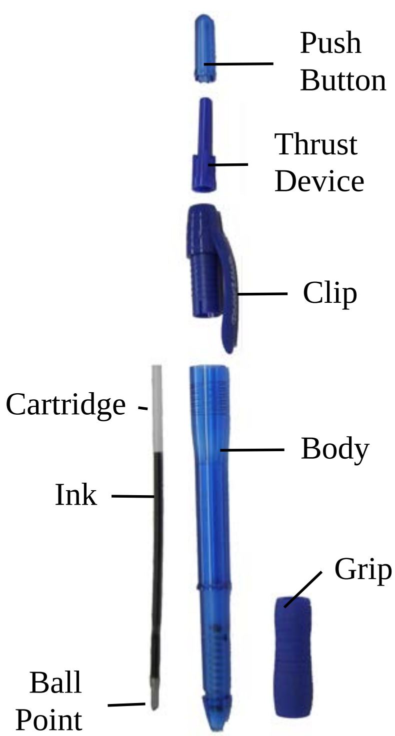

Figure 2. The Parts of a Pen.

Abstract

Diamond ATR accessories are known for the variety of samples that can be examined. These include everything from hard, curved samples to liquids. Some use monolytic diamond crystals which are virtually unbreakable, while others use diamond wafers which are more fragile. Because of the diamond lattice bands in the mid-infrared and price considerations, the pathlength through the diamond is generally as small as possible. These considerations impact performance and limit the signal-to-noise ratio, making it particularly important to have as much of the incoming light as possible reach the detector.

The DiaMaxATR (Figure 1) is a compact high throughput diamond ATR accessory. This work explores the variety of samples that can be examined by such an ATR accessory.

Experimental

All spectra with the DiaMaxATR single reflection diamond ATR (see Figure 1) installed in a commercial FTIR. The spectrometer coadded 32 scans collected at 8 cm^{-1} resolution. The background single beam spectra were collected using the clean diamond ATR. Sample spectra were collected by compressing the solid samples against the ATR crystal using the maximum force as limited by the built-in slip clutch. The ink was measured by simply placing a drop on the top of the crystal.

The sample used was a PaperMate Profile® pen. A new pen was disassembled for analysis.

Results and Discussion

The pen analyzed is shown in Figure 2, where the various sections examined are indicated. The resulting spectra are shown in Figures 3 through 7.

Figure 3 shows two approaches to measuring the spectra of the ink. The ink was examined as a liquid, by placing a drop on top of the crystal, and as a coating on the curved metal surface near the ball point. Both spectra are nearly identical. The spectrum showing the ink has much more intense bands due to the higher concentration and better contact with the ATR crystal. It is interesting to note that the spectra differ slightly. This is probably due to some combination of inhomogeneities in the sample and the interaction of the evanescent wave with the underlying metal in the case of the ink *in situ*.

Figures 4 through 6 show spectra from other parts of the pen. The composition of these components of the pen were

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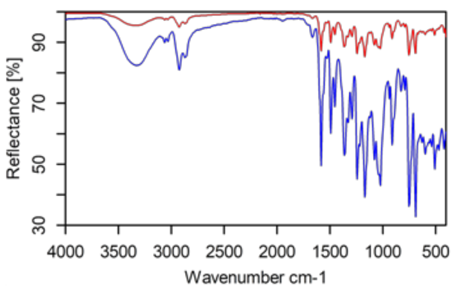

Figure 3. ATR spectrum of ink deposited on the crystal (blue) and ink on ball point (red).

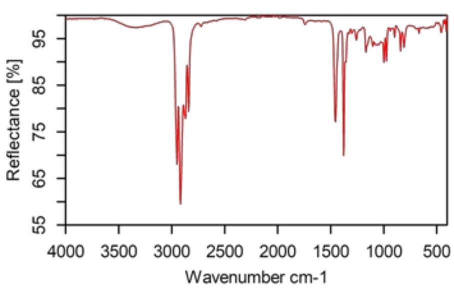

Figure 4. ATR spectrum of the outside of the cartridge.

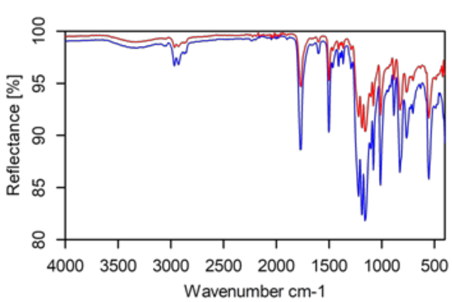

Figure 5. ATR Spectrum of the body (red) and the push button (blue).

readily identified using the library search included with the spectrometer. The outside of the ink cartridge (Figure 4) was conclusively identified as polypropylene. The spectra (Figure 5) of the body and push button of the pen are similar. Spectral searching indicates that they both are polycarbonates, although they are likely to be different formulations. Figure 6 shows the spectrum of the pen clip. This is clearly identified as polystyrene.

Figure 7 shows the spectra of the grip and thrust device.

Conclusion

We have demonstrated that the DiaMaxATR can be effectively used to examine the various parts of a pen. These represent a number of different types of samples, including coating on curved metals, curved plastics, pliable materials and liquids.

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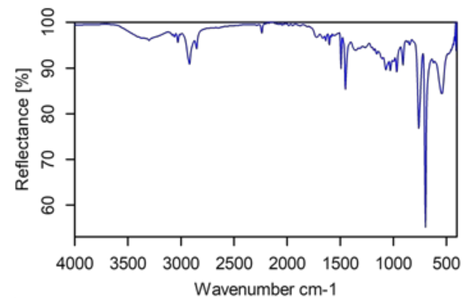

Figure 6. ATR spectrum of the clip.

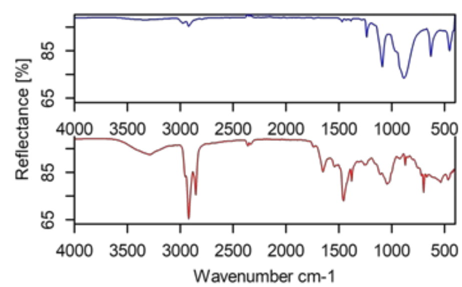

Figure 7. ATR spectrum of blue grip (red) and the thrust device (blue),

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