

Figure 1. The Diamond ConcentratIR2™.

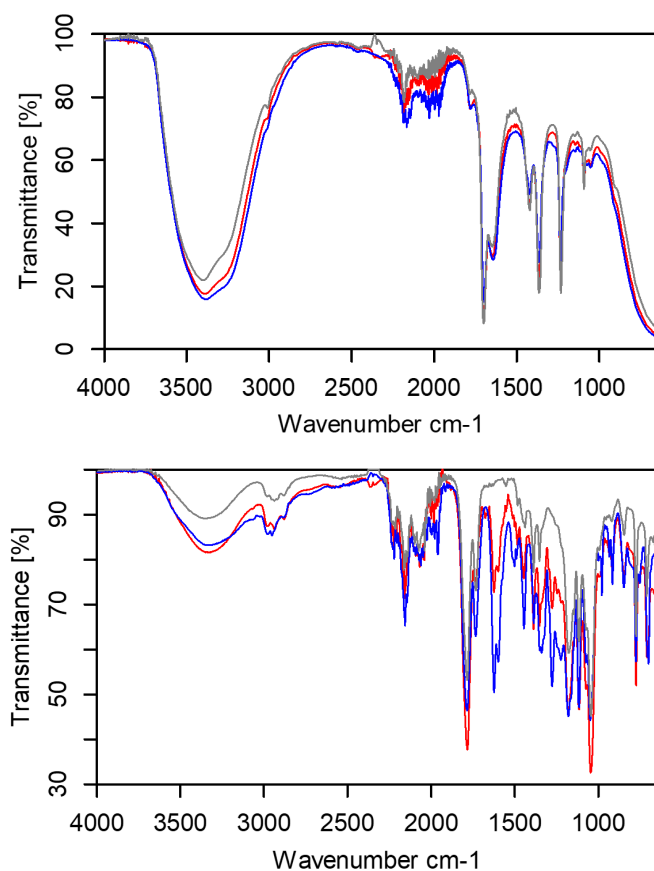


Figure 2. Spectra of samples before (top) and after (bottom) drying. Original (grey), strengthening (red) and nourishing (blue).

Analysis of Nail Polish Removers Using the Diamond ConcentratIR2™

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INTRODUCTION

Most household products are complex mixtures. If one of these components is volatile, as is often the case, trace analysis can be simplified by allowing the volatile liquids to evaporate. This is the case with nail polish remover, which typically contains a large number of substances dissolved in acetone. Depending on the components dissolved, the remover can be marketed as “nail strengthening” or “nourishing.”

In this experiment a Diamond [ConcentratIR2™](#) multiple reflection ATR (Figure 1) was used to detect and identify the minor chemical variability between different types of nail polish remover.

EXPERIMENTAL

The measurements were carried out using the ConcentratIR2 (Figure 1) in a commercial FTIR spectrometer equipped with a DTGS detector. Spectra were collected at 4 cm^{-1} resolution, a gain of 8, and signal averaged over 64 scans.

The nail polish removers analyzed were three different types from a single commercially available brand. The removers were labeled by the company as “original” formula, “nourishing,” and “strengthening.”

A single drop of each type was placed on the ATR diamond element, and infrared spectra were taken

every 4 minutes while the solvent evaporated. Spectra were collected over a range of 4000 cm^{-1} to 650 cm^{-1} .

RESULTS AND DISCUSSION

Figure 2 shows the spectra of the three nail polish removers before evaporation. The spectra are nearly identical because the all five substances have the same primary constituent, acetone (see Table 1).

Once the acetone evaporates, the spectral features of the minor components become more prominent, as shown in Figure 3. Many of the new peaks that emerge are present in all three samples. Only a few bands, in the 1600 cm^{-1} to 900 cm^{-1} region (Figure 3), are unique. This is in good accordance with ingredients listed on each bottle (Table 1), which shows that only a few substances are present in just one analyte.

Unique peaks include a H–C–H alkane bending peak at 1500 cm^{-1} which is probably from tocopheryl acetate, an ingredient found only in the “nourishing” formula remover. Characteristic peaks are also observed at 1225 cm^{-1} and 985 cm^{-1} which are likely due to panthenol, another element particular to the “nourishing” nail polish remover.

However it should be noted that some ingredients specific to one formula, such as citric acid (nourishing) and benzophenone-1 (strengthening) are present in quantities too small to be detected, by the roughly ten reflections provided by the Diamond ConcentratIR2™. Use of additional reflections, as provided by the extended sampling plate, might make these more apparent.

CONCLUSION

Multiple reflection diamond ATR accessories, such as the ConcentratIR2™, can be used effectively to measure some trace differences in the residues of complex solutions. Since the crystal is also only 4-mm in diameter, only single drops of the sample are required, making it extremely useful in situations where only limited quantities of sample area available.

	Regular	Nourishing	Strengthening
Acetone	√	√	√
Water	√	√	√
Propylene Carbonate	√	√	√
Dimethyl Glutarate	√	√	√
Panthenol		√	
Tocopheryl Acetate		√	
Dimethyl Succinate	√	√	√
Dimethyl Adipate	√	√	√
Glycerin	√	√	√
Gelatin	√	√	√
Denatonium Benzoate	√	√	√
Benzophenone-1			√
Propylene Glycol		√	√
Citric Acid		√	

Table 1. Nail polish removers contents in order of quantity, smallest to largest.

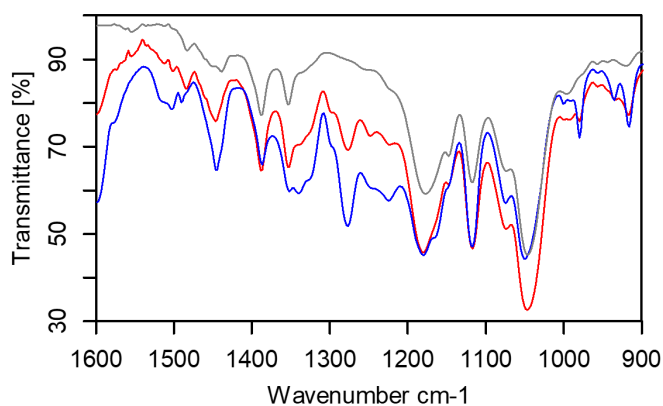


Figure 3. Spectra of all three samples, in the 1600 cm^{-1} to 900 cm^{-1} region. Original (grey), strengthening (red), and nourishing (blue) formulas.