



Figure 1. The [DiaMaxATR](#).

## Dissolution of Nail Polish Using Acetone

### INTRODUCTION

Diamond ATR can be useful for nail polish or paint manufacturers for quality control as well as developing or altering formulations. This can also apply to paint thinner or stain remover manufacturers in testing the effectiveness of their products. In this study, the dissolution of nail polish with acetone is examined using the DiaMaxATR™ accessory.

### EXPERIMENTAL

Infrared spectra were collected on an FT-IR spectrometer equipped with the Harrick DiaMaxATR™ single-reflection high throughput diamond ATR accessory. Spectra were collected at an  $8\text{ cm}^{-1}$  resolution, a gain of 1, and signal averaged over 32 scans. The aperture was set to 100%. Spectra were collected in the range  $4000\text{-}400\text{ cm}^{-1}$ . The instrument was purged to reduce water vapor and  $\text{CO}_2$  interferences.

The samples used were nail polish (O.P.I in “Over the Taupe”) and acetone. The ingredients listed by O.P.I in their MSDS include solvents: ethyl acetate, butyl acetate, isopropyl alcohol and propyl acetate; plasticizers: camphor, trimethyl pentanyl diisobutyrate and ethyl tosylamide; and polymers: nitrocellulose and tosylamide/formaldehyde resin.

One coat of nail polish was applied on the diamond ATR crystal and allowed to dry completely for 20 minutes while spectra were collected every 30 seconds using Harrick’s TempLink software. After a spectrum was taken of the dried nail polish, two drops of acetone were deposited on top of the dried nail polish. A sealed liquid cell was used to enclose the samples to reduce evaporation of acetone. Spectra were collected every 30 seconds for a total of 10 minutes.

### RESULTS AND DISCUSSION

Figure 2 displays the spectra of nail polish before and after it dries for 20 minutes. Initially, there is a broad band between  $3700\text{-}3200\text{ cm}^{-1}$ , which may be attributed to O-H bonds from the isopropyl alcohol. There are three peaks near  $3000\text{ cm}^{-1}$  ( $2966\text{ cm}^{-1}$ ,  $2937\text{ cm}^{-1}$ , and  $2876\text{ cm}^{-1}$ ), indicating there are C-H bonds, which could be from numerous ingredients, which include the polymer, solvents, resins, and plasti-

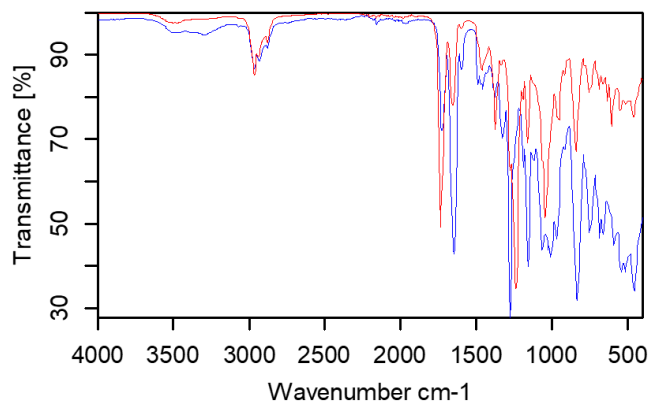


Figure 2. Spectra of nail polish right after 1 coat was applied on the diamond (red) and after the same coat of nail polish dried for 20 minutes (blue).

cizers. There is a peak at  $1736\text{ cm}^{-1}$  which is due to carbonyl (C=O) bonds found in the solvents: ethyl acetate, butyl acetate, and propyl acetate as well as one of the plasticizers, trimethyl pentanyl diisobutyrate. At  $1656\text{ cm}^{-1}$  there is a peak, which may be due to C=C stretching from cyclic alkenes in tosylamide/formaldehyde resin. After the polish dries, the initial band between  $3700\text{--}3200\text{ cm}^{-1}$  broadens and a second band emerges at  $3300\text{ cm}^{-1}$ . Although it is likely the isopropyl alcohol has evaporated, N-H bonds from tosylamide/formaldehyde resin may have contributed to the bands between  $3700\text{--}3200\text{ cm}^{-1}$  as the solvents evaporate and concentrate the remaining ingredients. The evaporation of the solvents is shown more clearly when observing the (C=O) peak at  $1736\text{ cm}^{-1}$  because it decreases in intensity and shifts to  $1725\text{ cm}^{-1}$  as the nail polish dries. The (C=C) peak at  $1656\text{ cm}^{-1}$  increases in intensity and shifts to  $1643\text{ cm}^{-1}$  as the tosylamide/formaldehyde resin concentrates.

Figure 3 compares a spectrum of nail polish immediately after two drops of acetone was deposited on the dry coat of nail polish and a spectrum collected 10 minutes later. Since the attraction between the polymer molecules are weaker than the attraction

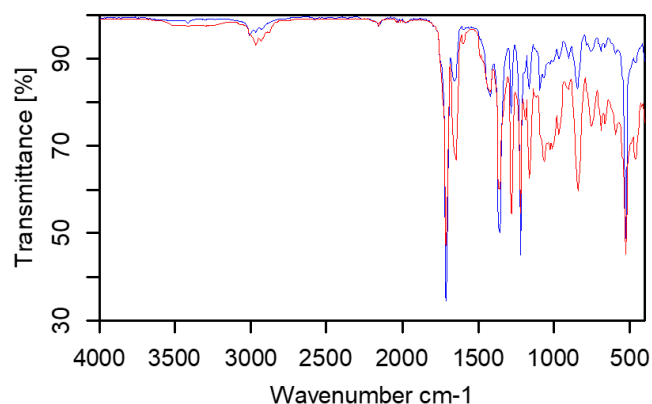


Figure 3. A comparison of a spectrum of dried nail polish right after 2 drops of acetone was deposited on top of it (red) and a spectrum collected 10 minutes later (blue).

between the acetone molecules and the polish polymer molecules, the polymer turns from solid to liquid. In figure 3, this is observed when comparing the (C=O) peak at  $1710\text{ cm}^{-1}$  after acetone was initially deposited and after 10 minutes. After 10 minutes with acetone, the peak intensity increased. As expected, the (C=C) peak at  $1644\text{ cm}^{-1}$  decreased in intensity and shifted to  $1657\text{ cm}^{-1}$ .

## CONCLUSION

Using diamond ATR, nail polish manufacturers can monitor the changes in their formulas as it dries to study how the effects of altering the formulation impact the overall performance of their products. Additionally, the dissolution of nail polish can also be examined to either enhance the durability of the polish or aid in the ease of removal. Similarly, paint thinner manufacturers can observe how their products perform over time while dissolving paint.