Figure 1. The SplitPea™ ATR Microsampler.

ATR Analysis of Hair Using The SplitPea™

INTRODUCTION

The IRS Nanosampler, first described in 1987, has evolved into a user friendly, horizontal ATR cell while still maintaining a small sampling area. The SplitPea™ (Figure 1) is available with easily changed germanium, silica, zinc selenide, or diamond Internal Reflection Elements (IRE). The small sampling area (250 micrometer diameter) is of importance in the examination of fibers, including hair fibers, since the fiber will cover a larger portion of the illuminated area of the IRE. For example, a human scalp hair fiber having an average diameter of 50 micrometers will cover about 25% of sampling area of the SplitPea™ IRE. This results in increased spectral absorbances compared to spectra obtained using ATR cells having larger illuminated sampling areas. Thus, one can study a single hair fiber rather than needing to mount multiple hair fibers on a sample card.

EXPERIMENTAL

Spectra were obtained on a FTIR spectrometer equipped with a liquid nitrogen cooled MCT detector using the SplitPea™ with a ZnSe IRE. A single hair fiber was mounted on a sample card designed to hold the

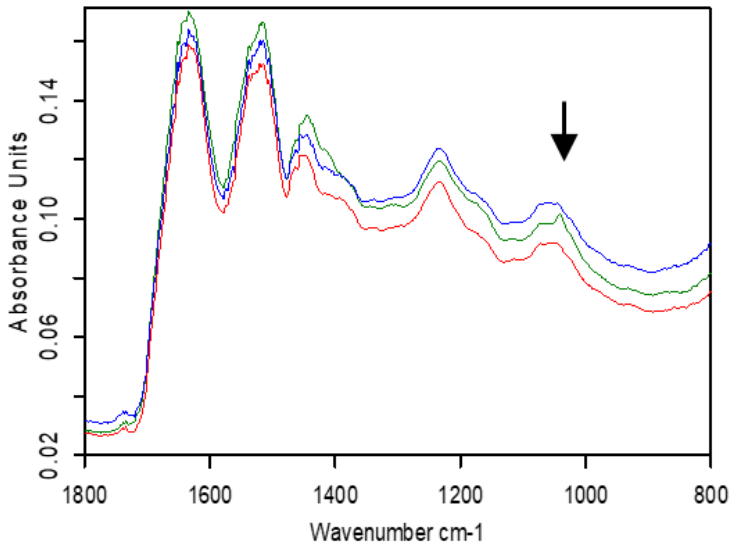

Figure 2: The 1800 to 800 cm-1 region of FTIR spectra of a human hair fiber taken at 10 mm (red), 45 mm (blue), and 80 mm (green) from the scalp end of the fiber. The 1040 cm^{-1} absorption (arrow) indicates oxidation of sulfur bonds in the more distal (80 mm) portion of the hair.

fiber in an alignment parallel to the IR beam. The pressure applicator was lowered until a slight movement of the pressure indicator occurred (pressure was still around zero). The FTIR-ATR absorption spectra were obtained from 4000 to 700 cm^{-1} using 128 scans at a resolution of 4 cm^{-1} and Norton-Beer medium apodization.

RESULTS AND DISCUSSION

While increases in absorptions do occur with increases in applicator pressure, minimum pressure should be applied. The hair fiber has a heterogeneous structure. Both its physical form and spectra can be altered by applying too much pressure.

Since the growth rate of hair fibers is known (averages 0.33 mm/day) and the hair is essentially dead tissue, it can provide a stable "time capsule" of biological events that have occurred in the body. Figure 2 shows the spectra obtained 10, 45, and 80 mm from the scalp end of a single hair fiber. This represents the age of the portion of the hair sampled (going back in time) of about 30, 136, and 242 days, respectively. In this hair sample, one can see that the only major difference in the spectra is the appearance of the band at about 1040 cm^{-1} due to the oxidation of sulfur bonds in the hair forming sulfonic acid groups. Note that the increase in intensity occurs in the portion of the hair more distal from the scalp (and thus more exposed to external factors such as sunlight or other oxidizing media). No changes were noted that were due to internal factors such as breast cancer.[5] However, with the small sampling area of the SplitPea™ and the ease of positioning a single hair fiber on the IRE one could easily determine weekly changes in the hair spectrum by obtaining spectra every 2.3 mm along the fiber shaft.

Thus, the SplitPea™ horizontal ATR cell should be useful in many types of studies involving hair, including detection of breast cancer. Although this author has only used the SplitPea™ ATR cell without the viewing microscope, I would highly recommend that SplitPea™ with the viewing microscope or the Video-Meridian™ for this type of study, since it would make reproducible positioning of the fine hair fiber on the IRE an easier task.

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