



Designation: F3416 – 21

Standard Guide for Using Fourier Transform Infrared Spectrometry to Evaluate Synthetic Equine Surface Components¹

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1. Scope

1.1 Infrared (IR) spectrophotometry involving IR microscopes, coupled with Fourier transform infrared (FTIR) spectrometers, is a valuable method of identifying polymeric fibers (that is, polypropylene, polyethylene, etc.) and rubber used in synthetic equine surfaces. FTIR may also be used to identify organic compounds and other non-metallic elements present in the binder (that is, high-oil wax) extracted from an equine surface. FTIR of wax-based binders can also detect and quantify relative degrees of binder oxidation. FTIR works by detecting and interpreting the oscillations of the atoms bonded together in the molecular structure. Infrared light absorption spectra are generated from samples tested, and these spectra are compared to libraries of known polymer spectra. For bulk fiber samples, different fibers are visually separated into groups and individual fibers from each group are tested. For extracted wax, several tests are conducted to ensure consistency. FTIR absorption spectrums for two common fibers are shown in Fig. 1. FTIR spectrum for a wax binder exhibiting oxidation peaks is shown in Fig. 2.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This guide is under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and is the direct responsibility of Subcommittee F08.28 on Equestrian Surfaces.

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2. Referenced Documents

2.1 ASTM Standards:²

D7414 Test Method for Condition Monitoring of Oxidation in In-Service Petroleum and Hydrocarbon Based Lubricants by Trend Analysis Using Fourier Transform Infrared (FT-IR) Spectrometry

E1459 Guide for Physical Evidence Labeling and Related Documentation

E1492 Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory

E2224 Guide for Forensic Analysis of Fibers by Infrared Spectroscopy

3. Terminology

3.1 Definitions:

3.1.1 *absorbance (A), n*—the logarithm to the base 10 of the reciprocal of the transmittance, (T): $A = \log_{10}(1/T) = -\log_{10}T$

3.1.2 *absorption band, n*—a region of the absorption spectrum in which the absorbance passes through a maximum.

3.1.3 *absorption spectrum, n*—a plot, or other representation, of absorbance, or any function of absorbance, against wavelength, or any other function of wavelength.

3.1.4 *background, n*—apparent absorption caused by anything other than the substance for which the analysis is being made.

3.1.5 *Fourier transform, n*—a mathematical operation that converts a function of one independent variable to one of a different independent variable.

3.1.6 *Fourier-transform infrared spectroscopy (FTIR), n*—a technique in which a material of interest is subjected to an infrared spectrum and absorption is measured over the specified spectral range.

3.1.7 *transmittance (T), n*—the ratio of radiant power transmitted by the sample, I , to the radiant power incident on the sample, I_0 .

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

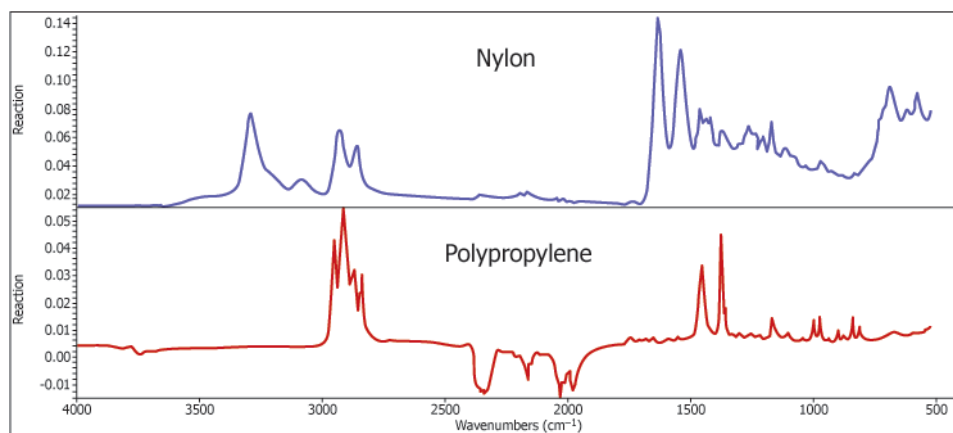


FIG. 1 FTIR Identification of Polymer Types in Bulk Fiber

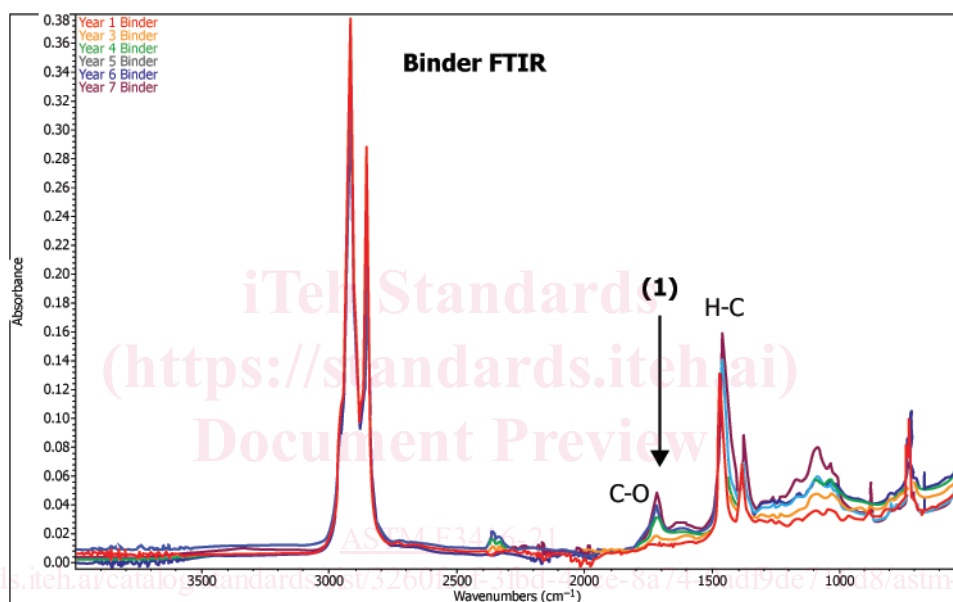


FIG. 2 Oxidation Activity in Wax Binder over Multiple Years (Note Oxidation Peak at $\sim 1700\text{ cm}^{-1}$ (1))

3.1.8 *wavelength, n*—the distance, measured along the line of propagation, between two points that are in phase on adjacent waves.

4. Summary of Guide

4.1 This guideline covers identification of fiber polymer and wax binder composition by interpretation of absorption spectra obtained by infrared spectroscopy. Additional testing and analysis information can be found by consulting the reference documents.

5. Significance and Use

5.1 FTIR can quickly be utilized to help identify polymeric fibers and some inorganic materials. FTIR also provides a means of monitoring changes to equine surface binder materials, in addition to observing oxidation.

6. Sample Handling

6.1 The general handling and tracking of samples should meet or exceed the requirements of Practice E1492 and Guide E1459.

6.2 The quantity of wax binder or fiber used and the number of fiber samples required will differ according to:

- 6.2.1 Specific technique and sample preparation,
- 6.2.2 Sample homogeneity,
- 6.2.3 Condition of the sample, and
- 6.2.4 Other case dependent analytical conditions or concerns, or both.

6.3 Sample preparation should be similar for all fibers or wax binders being compared.

6.4 Fibers should be flattened prior to analysis in order to obtain the best quality absorption spectra. Flattening or compressing the fibers can alter the crystalline/amorphous structure of the fiber and result in minor differences in peak frequencies and intensities. This must be taken into consideration when making spectral comparisons. Leaving the fiber uncompressed, while allowing crystallinity-sensitive bands to be observed unaltered, results in distortion of peak heights due to variable pathlengths. In certain situations, a combination of both approaches is advisable.