

Frontier Analysis, Ltd

TECHNICAL SERVICE RESPONSE NO.: UT087

Subject: Analysis of a Fragment Observed Falling from an Unidentified Aerial Object (UAO) Claymont Delaware, June 29, 2014 (CMS Case File: 57833)

Date: September 26, 2014

Requested By: Dave Segal
MUFON FI - PA and DE

Reported By: P. A. Budinger
Analytical Scientist

Background/Objective:

Four witnesses of the event include a man, his wife, and two tenants who rent an upstairs room in their house. The tenants were outside about midnight on June 29th smoking cigarettes when they observed multiple orange-red unidentified aerial objects descend over their neighborhood. At the height of the event there were up to 24 objects. They were silent and floated irregularly. One of the tenants filmed the event using his SamSung Galaxy S5 phone. Toward the end, the objects appeared to slowly and silently move off into the distance in sort of a formation. One orb was still floating behind the others and acting irregularly as if it were malfunctioning. It seemed to drop/jettison something that burnt wildly the whole way down to earth. This was now about 1 a.m. Then the object instantly “darted” out of sight going in another direction than the other objects. (It went back “in the direction it came from.”) The ‘fireball’ dropped straight down, being a fairly windless night, taking about 10 seconds. It landed four houses up the street. The yellow flame reached about 2’ in height, which was eventually stomped out. The residual fragment was retrieved and kept in a small Styrofoam container until MUFON investigators arrived. The objective is to identify the composition of the fragment to determine whether it is anything anomalous. Following is a photograph of the fragment.



Conclusions:

- The sample is composed of greater than 50 wt.% palmitic acid (a long chain carboxylic acid also known as hexadecanoic acid) which is dispersed in fine glass fibers. Small amounts of other components are present, which are mostly comprised of other long chain carboxylic acids. These are probably impurities that come along with the palmitic acid, i.e. not refined out. There are also trace amounts of quartz which are commonly seen in glass fibers and an unidentified ester-type impurity.
- There are research publications on the use of palmitic acid as a phase change material (PCM)¹ for thermal energy storage.² More specifically, one recent publication discusses palmitic acid/SiO₂ (SiO₂ in fibrous glass form) composites for this purpose.³ There is visual indication that the glass fiber in this fragment may be one that is used in situations where it is exposed to high temperatures.⁴ So a possible speculation is that this fragment is from some sort of energy storage process related to the UAO.
- The most common use of material containing glass fiber is insulation. And, in fact the fragment has the appearance of insulation. However, the presence of palmitic acid

¹ A PCM is a substance with a high heat of fusion which, melting and solidifying at a certain temperature, is capable of storing and releasing large amounts of energy. Heat is absorbed or released when the material changes from solid to liquid and vice versa.

² Ahmet Sari, Kamil Kaygusuz, *Energy Conversion and Management*, Volume 43, Issue 6, April 2002, Pages 863-876 (Thermal performance of palmitic acid as a phase change energy storage material); Afif Hasan, *Solar Energy*, Volume 52, Issue 2, February 1994, Pages 143-154 (Phase change material energy storage system employing palmitic acid).

³ Guiyin Fang, Hui Li, Zhi Chen, Xu Liu, *Solar Energy Materials and Solar Cells*, vol.95, no. 7, pp. 1875-1881, 2011 (Preparation and properties of palmitic acid/SiO₂ composites with flame retardant as thermal energy storage material).

⁴ It is estimated that there are in excess of 50,000 chemical compositions for glass (MATERIALS HANDBOOK, by George S Brady and Henry R Clauser).

appears be unusual. Though one of palmitic acid's properties is waterproofing, no reference was found for it being used in insulating products.

- This fragment does not originate from Chinese Lanterns. Lanterns are made a myriad of recyclable and indigenous materials, none of which are of the composition noted above. In China they are traditionally made from oiled rice paper on a bamboo frame. The source of hot air may be a small candle or fuel cell composed of a waxy combustible material.⁵ Numerous websites describe many construction materials for making homemade lanterns. Indigenous materials like tree bark and fruit shells are used in some locations. Recycled materials are common such as: magazines, newspaper, plastic bottles, ribbon and string. Usually candles are the fuel source.

Procedure:

Sample: The fragment which fell from the UAO was received on 21 July 2014. It weighed 0.78 grams.

Infrared spectra were obtained from the surface of the sample 'as received'. A portion of the sample was quantitatively extracted with hexane, then acetone. Then infrared spectra were obtained from hexane solubles, acetone solubles and the remaining insolubles. All FT-IR (Fourier Transform-Infrared Spectra)⁶ were acquired on the Thermo Electron Avatar 360 spectrometer using the Smart Herrick diamond sampling accessory.

Microscope photographs were obtained using a Canon A520 digital camera interfaced to a Leica GZ6 stereomicroscope.

Results:

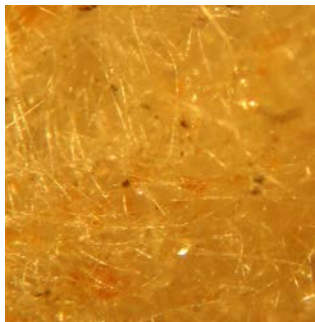
The detailed results of the individual tests done on the fragment follow. These results are summarized in the conclusions section on page one and two of this report.

Microscopic Examination

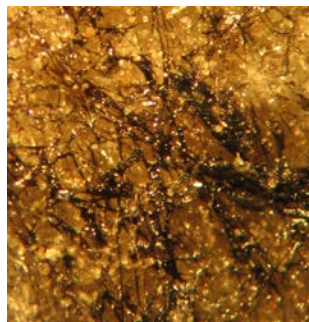
Microscopic examination of the fragment shows droplets/particulates of material on a fibrous matrix. Following are two photographs. One shows an unburned area with droplets. The second shows the burned area which is discolored due to charring of the organic materials. The droplets are not as apparent.

⁵ http://en.wikipedia.org/wiki/Sky_lantern.

⁶ **FT-IR (Fourier Transform Infrared Spectroscopy):** Infrared spectroscopy is used for the molecular structure identification and quantification of solids, liquids, and gases. An infrared spectrum is the result of light (in the 2 to 25 micron wavelength range) interacting with the vibrations of molecules. The particular set of vibrations of a molecule gives rise to specific spectral absorption bands, often referred to as the "fingerprint" spectrum.

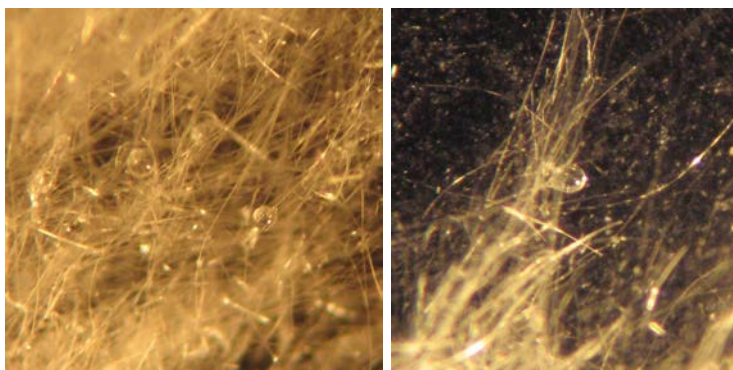


Unburned Area

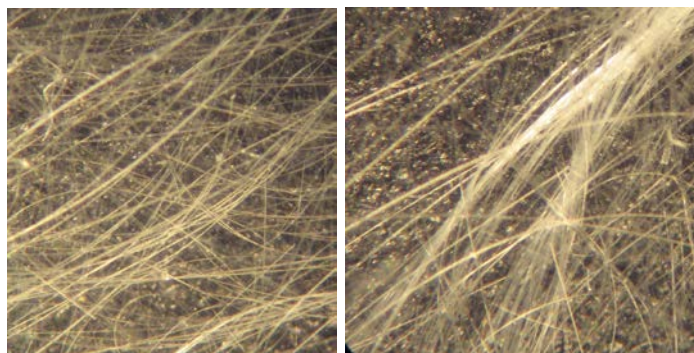


Burned Area

More micro pictures taken of the glass fibers, after all the organic components were removed by hexane and acetone extraction, show fibrous material. The strands are not long. Of interest are spheroid structures one of which appears to be attached to the end of the fiber. I am informed that a high temperature insulation product such as Fiberfrax has these spheres.⁷ I was unable to obtain a sample of this material for reference. Photographs of the 'cleaned' glass fibers along with glass wool and house insulation references follow. The reference fibers are longer and appear thicker. Also they do not have spheroids.

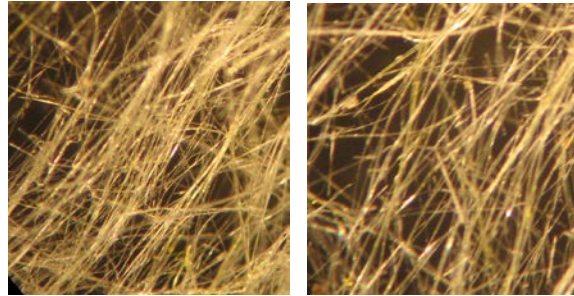


Hexane, Acetone Washed Glass Fiber



Glass Wool References

⁷ Bruce Budinger, Chemist specializing in ceramic composites, personal communication.

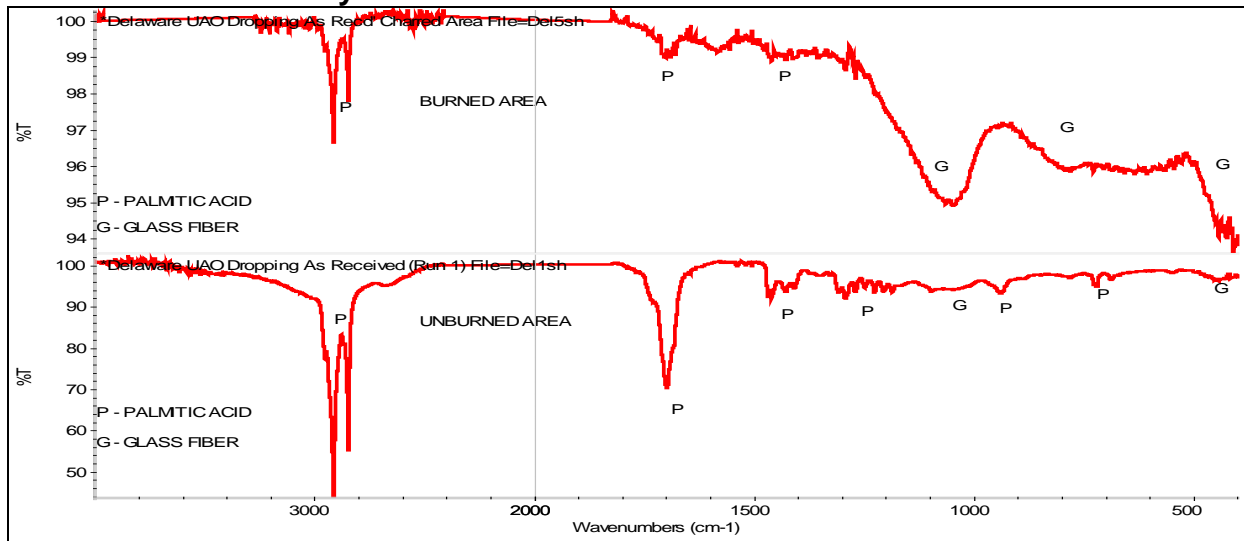


House Insulation References

Infrared Analysis of the 'As received' Fragment

Infrared analysis of the sample 'as received' identifies mostly palmitic acid and smaller amount of glass-like material in the unburned area. The burned area spectrum displays mostly glassy material and a very small amount of palmitic acid, showing most had burned away. The identifications of these materials are discussed further in the discussion of the solvent extraction spectra below. The 'as received' spectra follow.

Infrared Analysis of the 'As Received' Burn and Unburned Areas



Infrared Analysis of the Fractions Resulting from Solvent Extractions

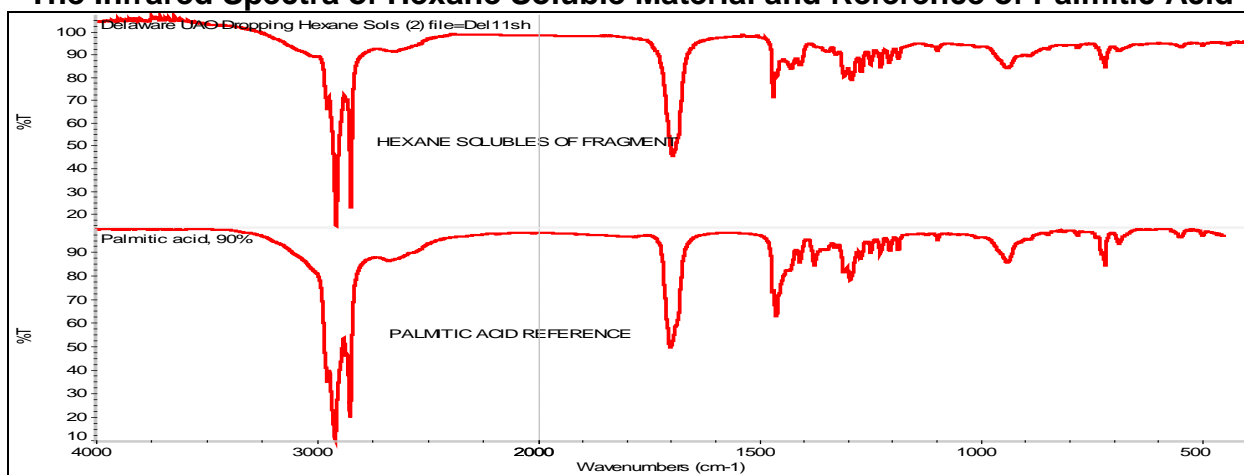
Extractions (hexane followed by acetone) were done to isolate the components of the fragment for better identification by infrared spectroscopy. Each fraction was weighed. However, the values are likely skewed toward the glass fiber because some of the organics undoubtedly burned away. This analyst believes the palmitic acid is greater than 50 wt.% of the total sample. The following table shows the approximate amounts and the infrared characterization of each fraction.

Fraction	Wt. %	Infrared Identification
Hexane	32*	Palmitic acid (a long carbon chain carboxylic acid also known as hexadecanoic acid).
Acetone	7	A mix of longer carbon chain) carboxylic acids. These are probably impurities, not refined out, which came along with the palmitic acid. A trace amount of an unidentified ester-type impurity is detected.
Insolubles	61	Glass Fiber; trace amounts of quartz.

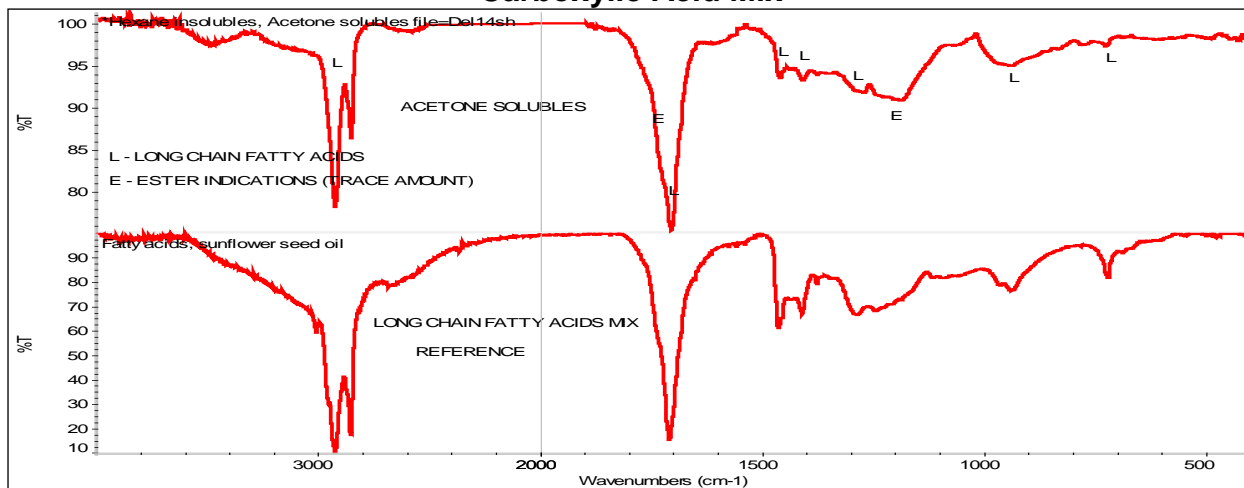
*Suspected to be significantly higher because some may have burned away.

The infrared spectra follow along appropriate references for comparison. Characteristic peak assignments for the functional groups are additionally included in the solvent insoluble spectrum.

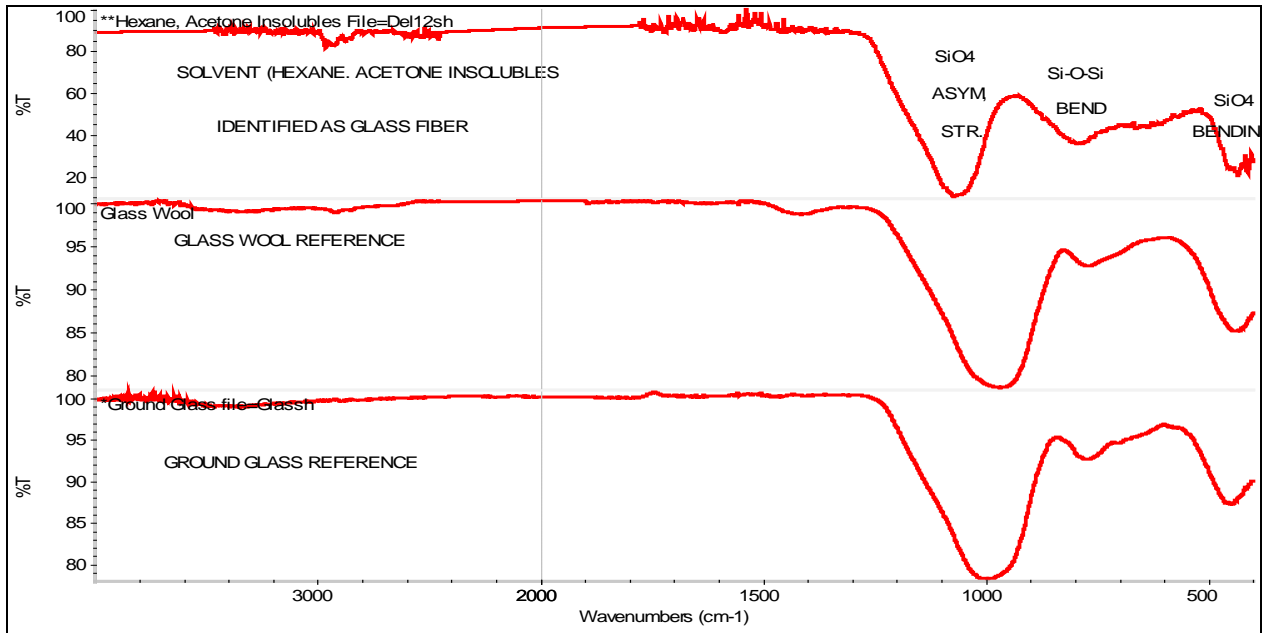
The Infrared Spectra of Hexane Soluble Material and Reference of Palmitic Acid



Infrared Spectra of Acetone Soluble Material and Reference of Long Chain Carboxylic Acid Mix



Infrared Spectra of Insoluble Material and References of Glass Wool and Ground Glass



It was noted that trace amounts of particulates were found in the isolated glass fibers. Infrared analysis identified them as quartz, a common impurity found in some glass fibers.

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