

ERA24FA110

## **AIRWORTHINESS**

Group Chair's Factual Report – Attachment 5

GE Research CF34 Filter Analysis 051624

May 8, 2025

# — GE Aerospace Research CF34 Filter Analysis

— GE Aviation Research  
Originally Shared: May 3 2024

**Active Investigation** – The information contained in this document is provided in response to a request from the National Transportation Safety Board (NTSB) and pertains to an active investigation. This document and its contents are intended solely for the purposes of the referenced investigation

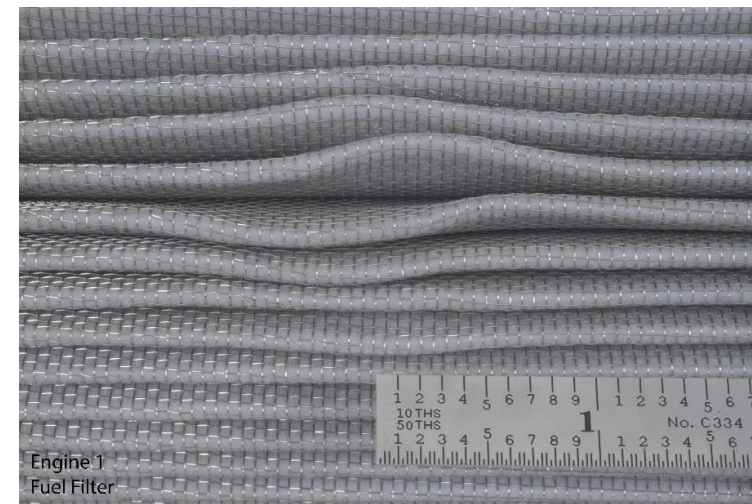
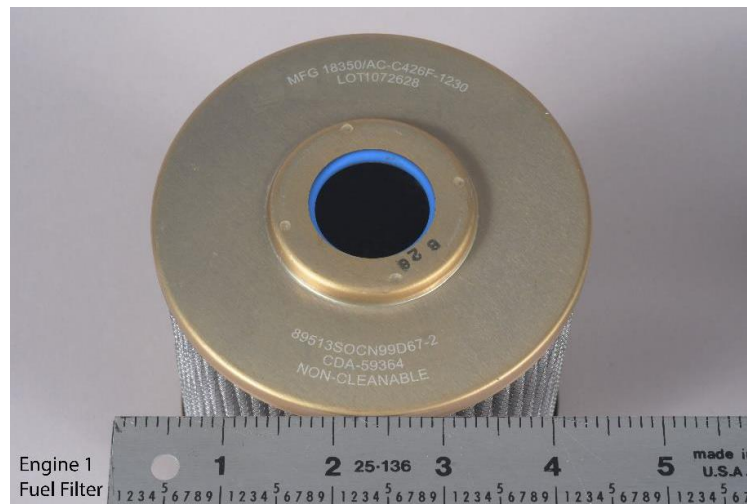
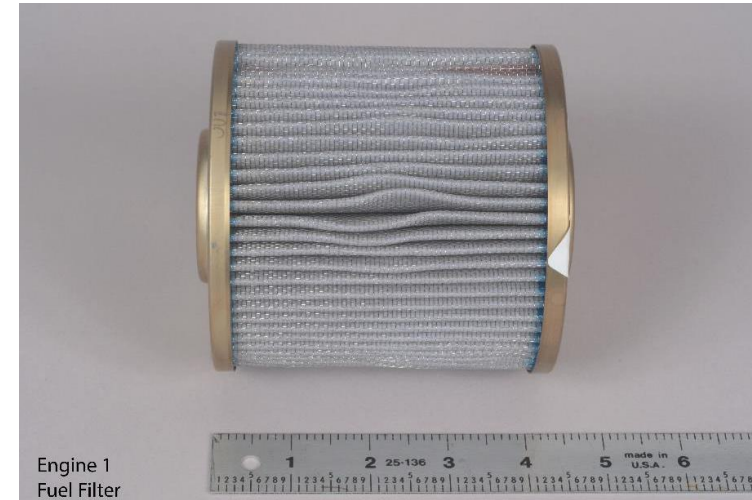
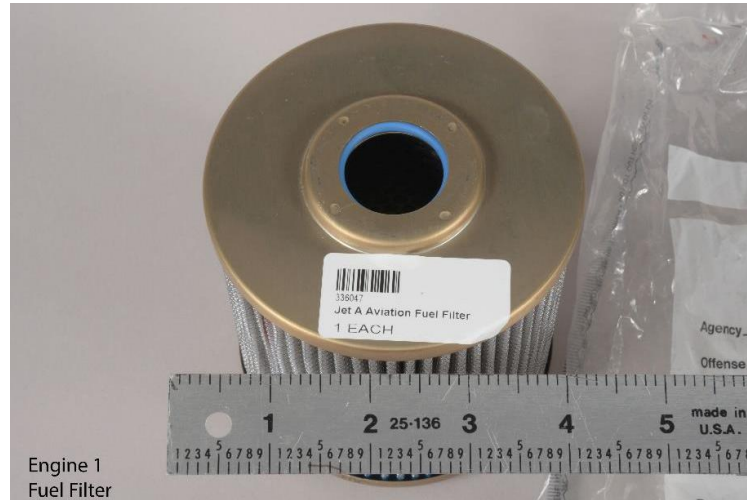
# Summary of Findings – Fuel Filter Analysis

- The filters were disassembled to expose their cloth filter layers which were then examined under an optical microscope. Particles on the filter were collected and analyzed by IR spectroscopy to determine their chemical composition.
- Representative particle types identified on each filter are detailed in the table below
- Small pieces of epoxy resin and fluorosilicone sealant were found on both the main fuel filters and the APU filter. Both of these materials are common contaminants seen in past evaluations of fuel filters.
- One small area of proteins (biological contamination) was found on the Engine 2 fuel filter
- The APU filter contained numerous small, light blue particles made of a poly(hexyl methacrylate) hard plastic. While the total quantity of these particles was low (a few dozen), they were the most common type of particle on the APU filter
- The filters were also screened for the presence of SAP or other gel-like contaminants by staining the filter material with a copper sulfate solution. No particles/gels were found that could be attributable to SAP or Diesel Exhaust Fluid (DEF) were detected

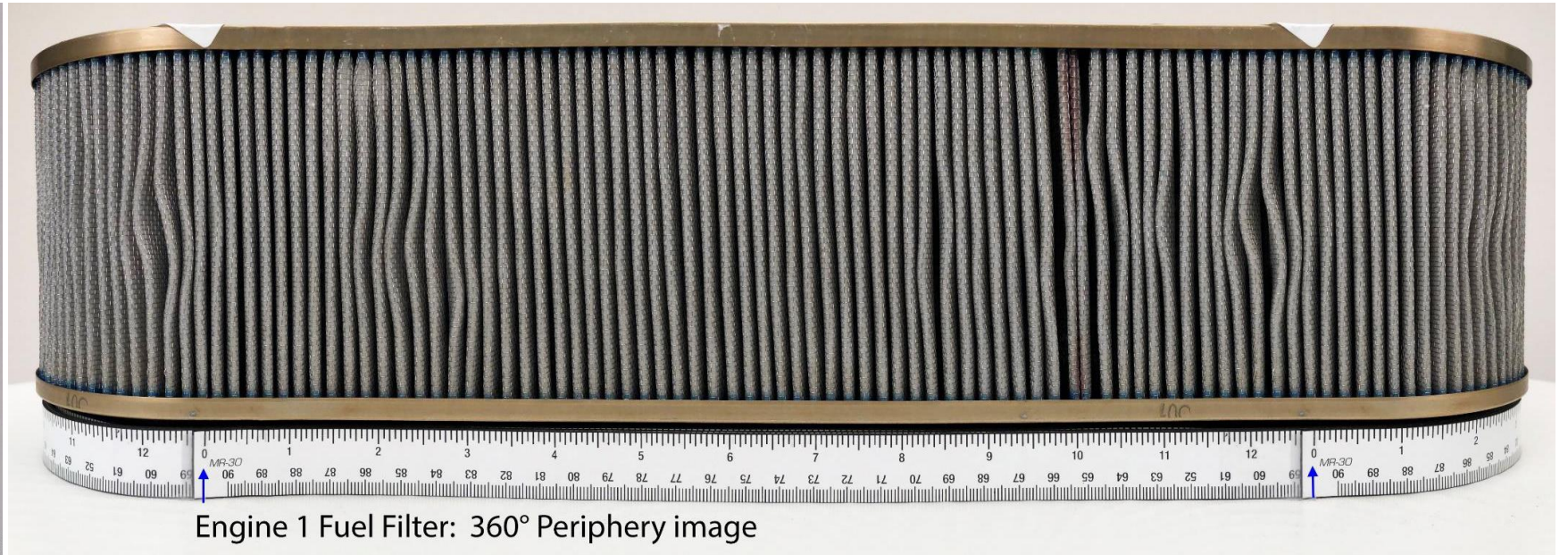
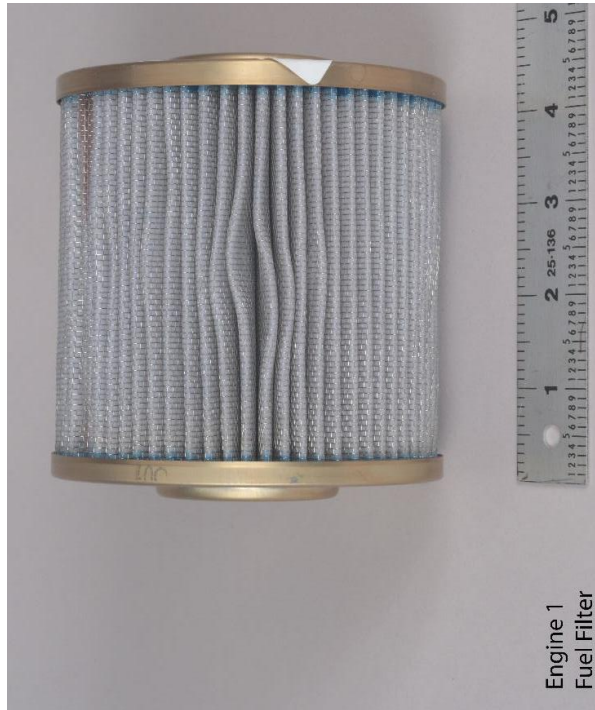
| Barcode | Sample               | Particles from IR spectroscopy                                                          |
|---------|----------------------|-----------------------------------------------------------------------------------------|
| 336047  | Engine 1 fuel filter | fluorosilicone sealant, epoxy resin                                                     |
| 336048  | Engine 2 fuel filter | epoxy resin, proteins (biological contamination),                                       |
| 336049  | APU filter           | fluorosilicone sealant, epoxy resin<br>light blue particles of poly(hexyl methacrylate) |

# – Optical Images of As Received Fuel Filters

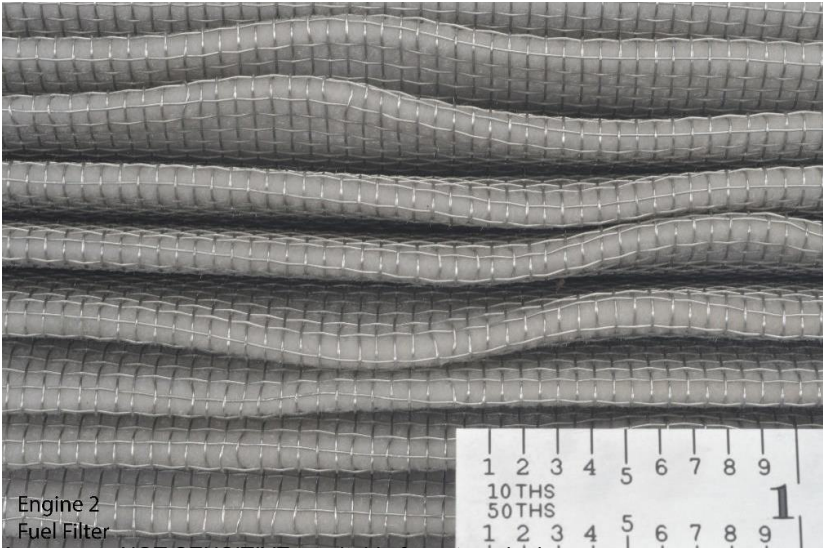
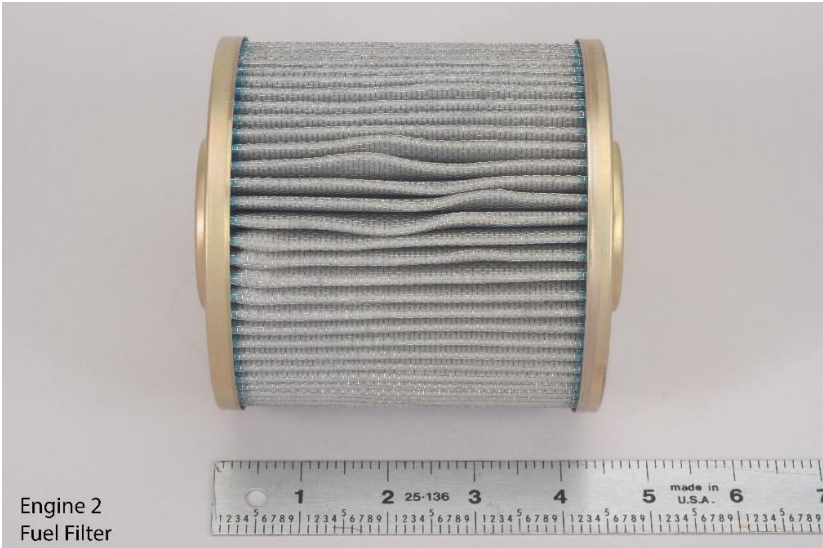
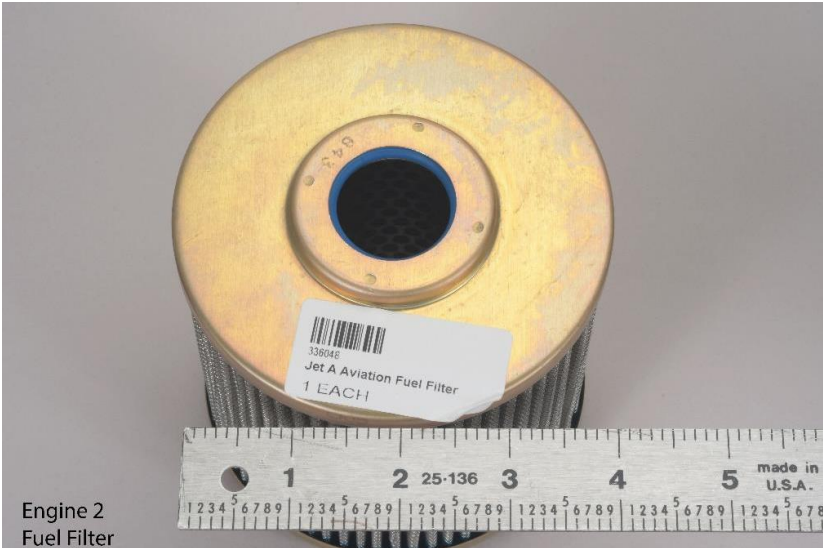
## Pictures of as-received 336047 Engine 1 fuel filter



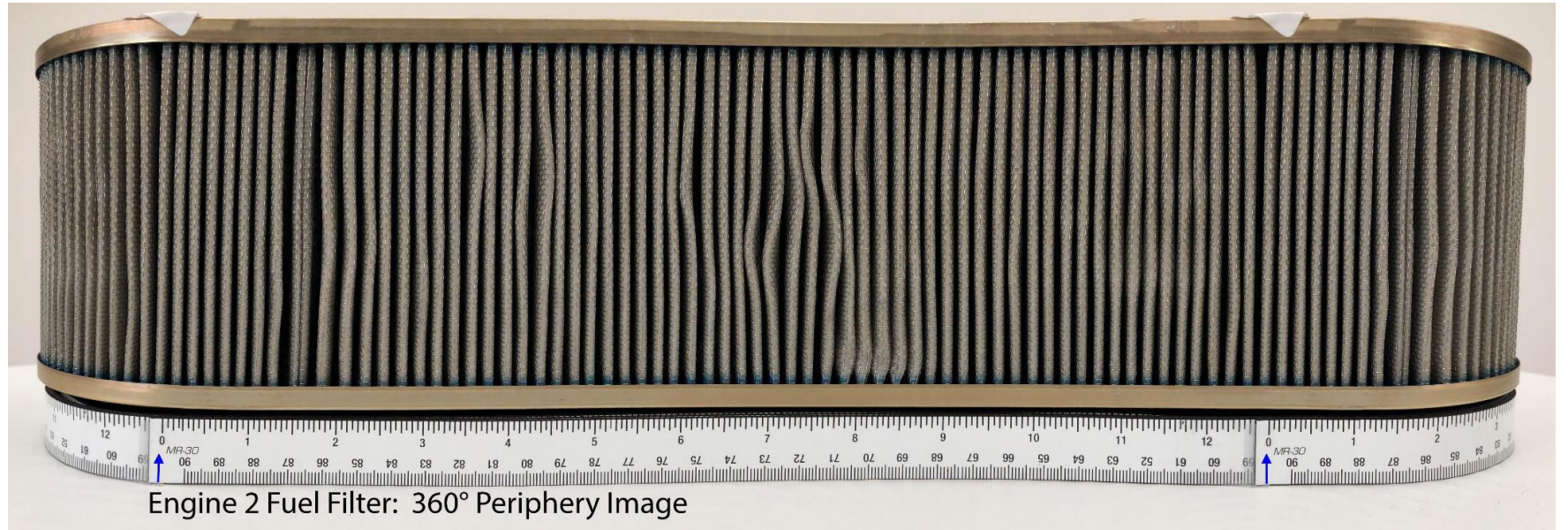
## 360 view of as-received 336047 Engine 1 fuel filter



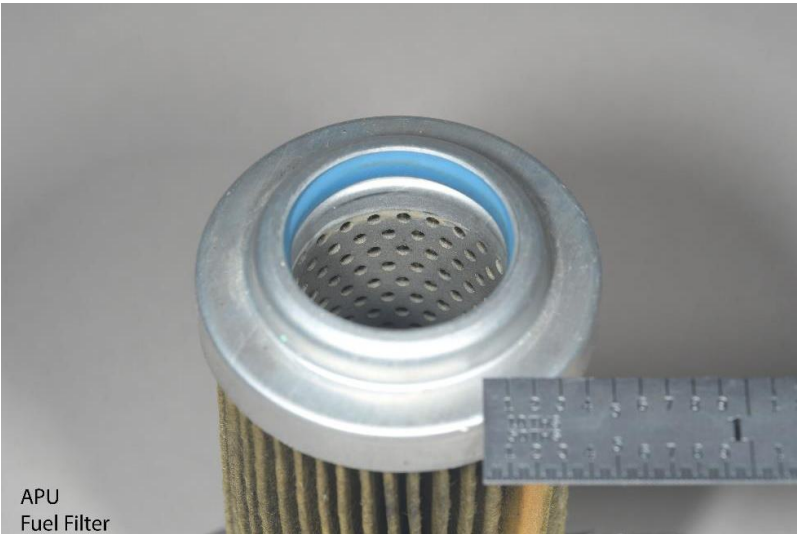
Pictures of as-received 336048 Engine 2 fuel filter



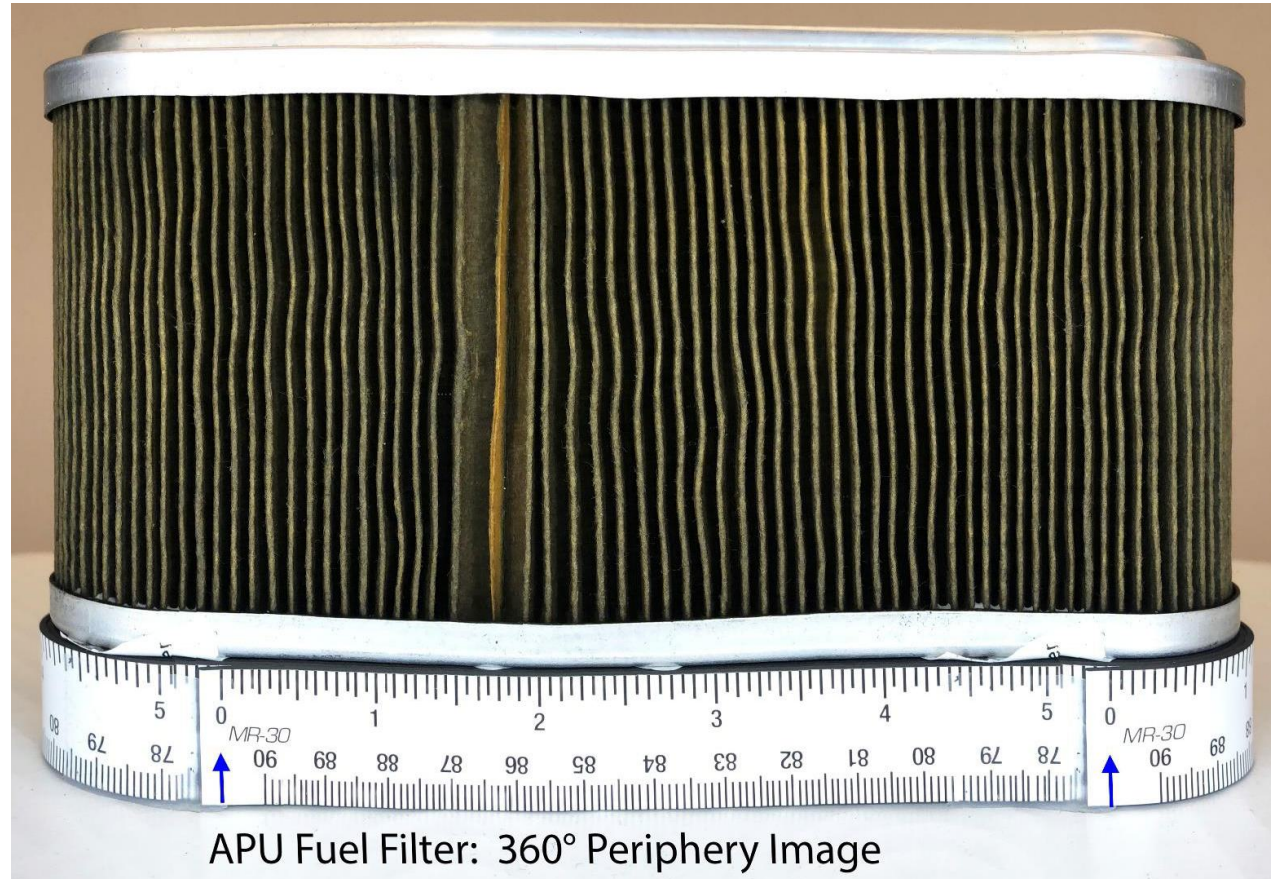
## 360 view of as-received 336048 Engine 2 fuel filter



Pictures of as-received 336049 APU filter



### 360 view of as-received 336049 APU filter



APU Fuel Filter: 360° Periphery Image

- Disassembly of Fuel Filters and Screening for SAP

# Screening for SAP (Super Absorbent Polymer) Contamination

- The filter housings were disassembled and sections of the filter layers were soaked in a 10% copper sulfate solution for 10mins, followed by a soak in DI water for 10mins to rinse off the remaining copper sulfate using the IATA Guidance procedure (1).
- The filter layers were then examined under an optical microscope to look for swollen particles stained blue by the copper sulfate solution
- **No SAP or other gel like particles were observed on the main fuel filters or the APU filter**

(1) IATA Guidance Material Investigation and Categorizing of Engine Fuel Filter Blockages, Section 6.1.2 Super Absorbent Polymer (SAP) Analysis

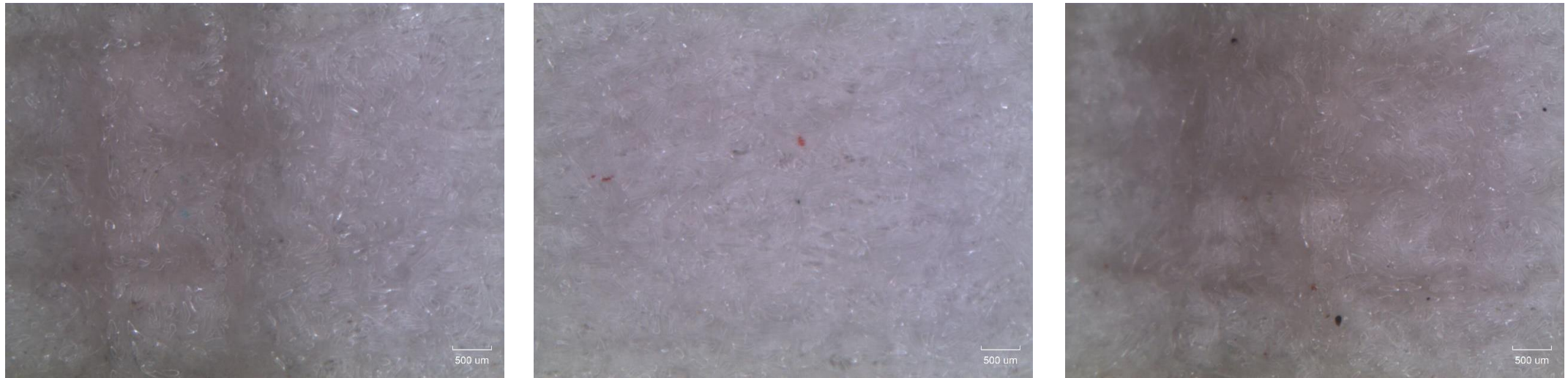
Disassembly of Engine 1 fuel filter soaking



Engine 1 fuel filter soaking in copper sulfate bath



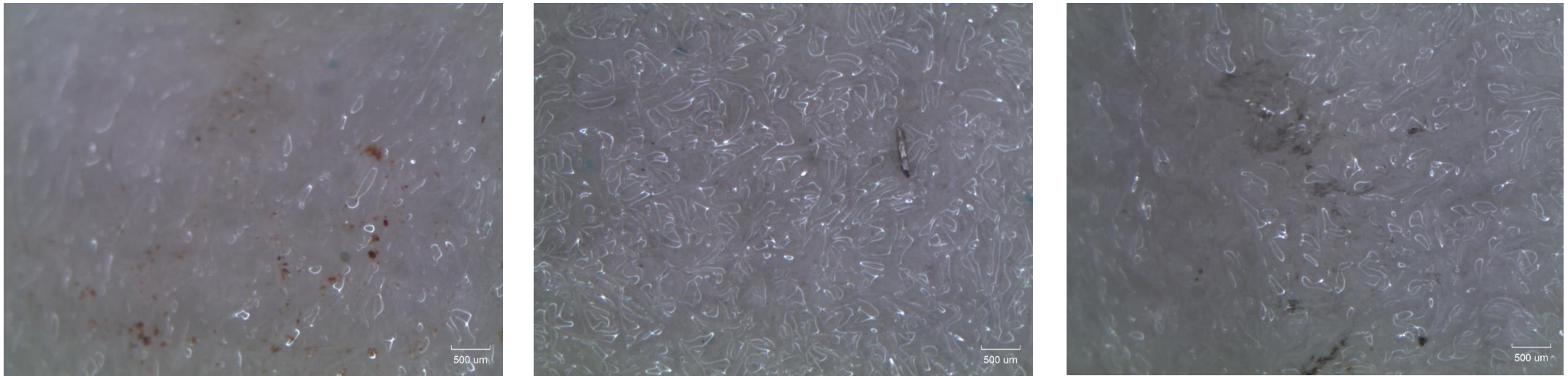
## Optical microscope images of 336047 Engine 1 fuel filter after staining with copper sulfate



Representative microscope images of the stained filter material are shown

No SAP particles or other water adsorbing gels were observed on the filter

## Optical microscope images of 336048 Engine 2 fuel filter after staining with copper sulfate



Representative microscope images of the stained filter material are shown

No SAP particles or other water adsorbing gels were observed on the filter

## Optical microscope images of 336049 APU filter after staining with copper sulfate



Representative microscope images of the stained filter material are shown

No SAP particles or other water adsorbing gels were observed on the filter

- Analysis of Material Caught on Main Fuel Filters and APU Filter

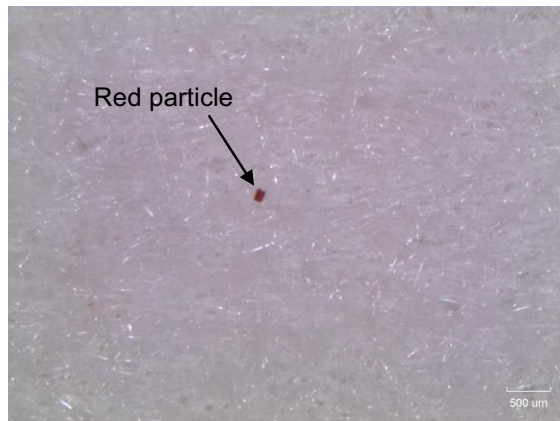
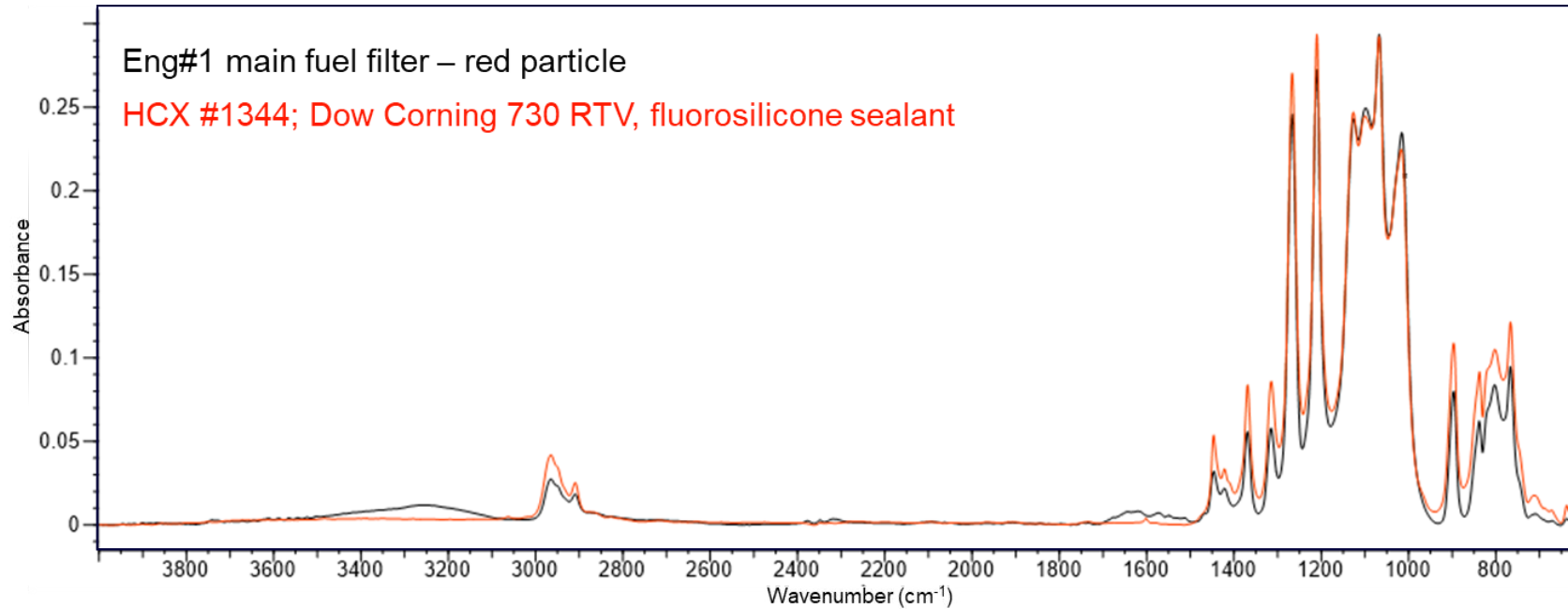
# Summary of Findings – IR Analysis of Particles from Fuel Filters

- The fuel filters were disassembled to expose their cloth filter layers which were then examined under an optical microscope. Particles on the filter were collected and analyzed by IR spectroscopy to determine their chemical composition.
- Representative particle types identified on each filter are detailed in the table below
- Small pieces of epoxy resin and fluorosilicone sealant were found on both the main fuel filters and the APU filter. Both of these materials are common contaminants seen in past evaluations of fuel filters.
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| Barcode | Sample               | Particles from IR spectroscopy                                                          |
|---------|----------------------|-----------------------------------------------------------------------------------------|
| 336047  | Engine 1 fuel filter | fluorosilicone sealant, epoxy resin                                                     |
| 336048  | Engine 2 fuel filter | epoxy resin, proteins (biological contamination),                                       |
| 336049  | APU filter           | fluorosilicone sealant, epoxy resin<br>light blue particles of poly(hexyl methacrylate) |

# IR Spectroscopy of Particles from 336047 Engine1 Fuel Filter

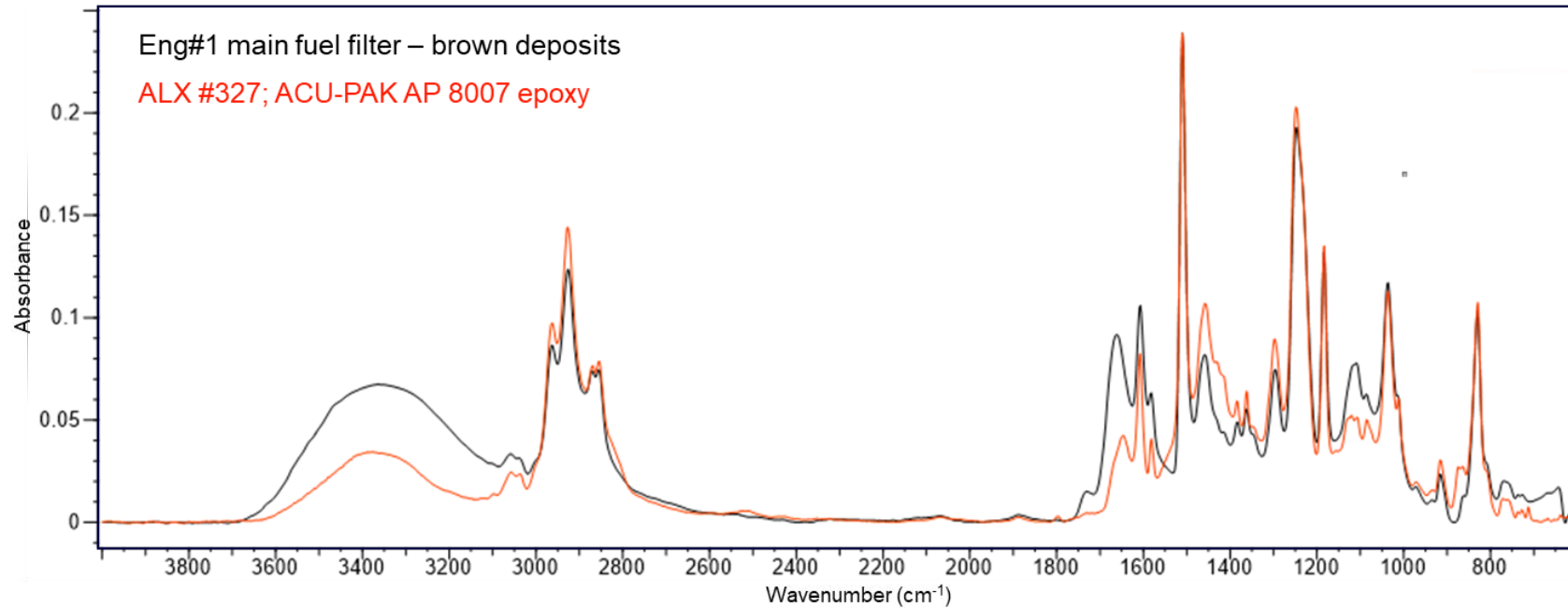
## Comparison to IR Spectral Database



Red chunks of pliable, soft material were found on the surface of the 336047 Engine1 fuel filter. These red particles are an excellent match to the IR fingerprint of a **fluorosilicone sealant**.

# IR Spectroscopy of Particles from 336047 Engine1 Fuel Filter

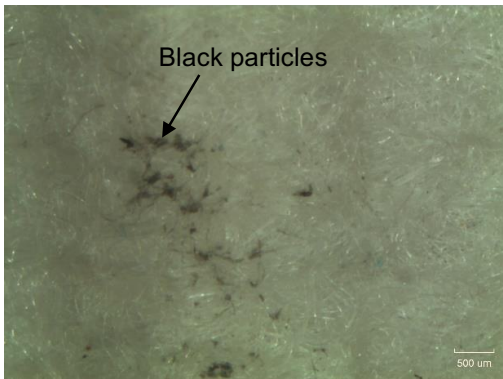
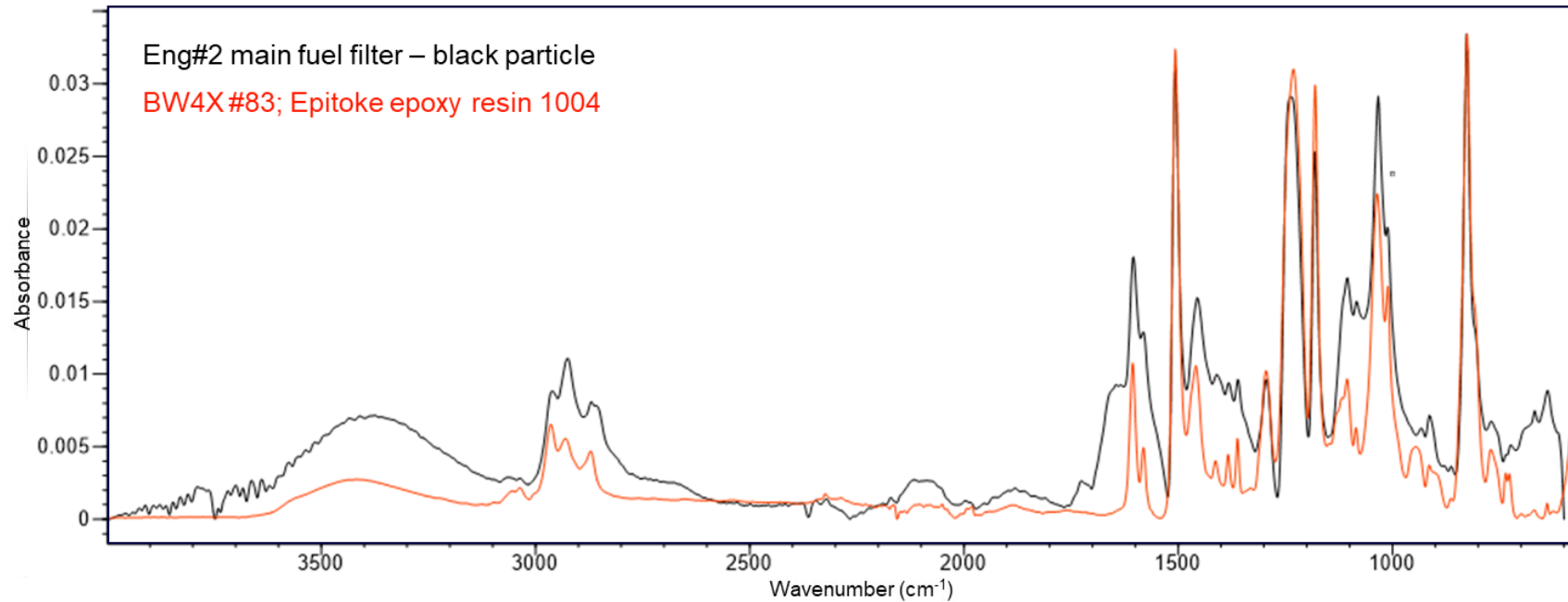
## Comparison to IR Spectral Database



Pieces of brown material were found on the surface of the 336047 Engine1 fuel filter. These brown deposits are an excellent match to the IR fingerprint of an **epoxy resin based on DGEBA/polyamide**.

# IR Spectroscopy of Solid Particles from 336048 Engine2 fuel filter

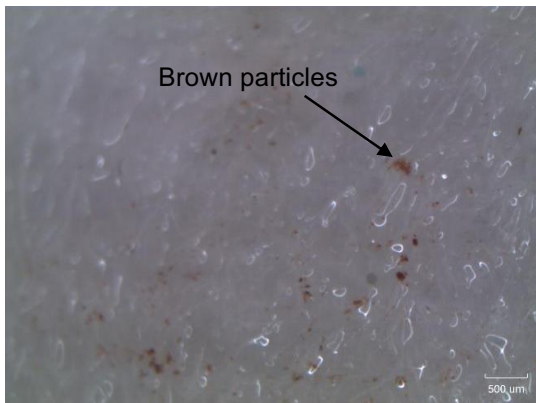
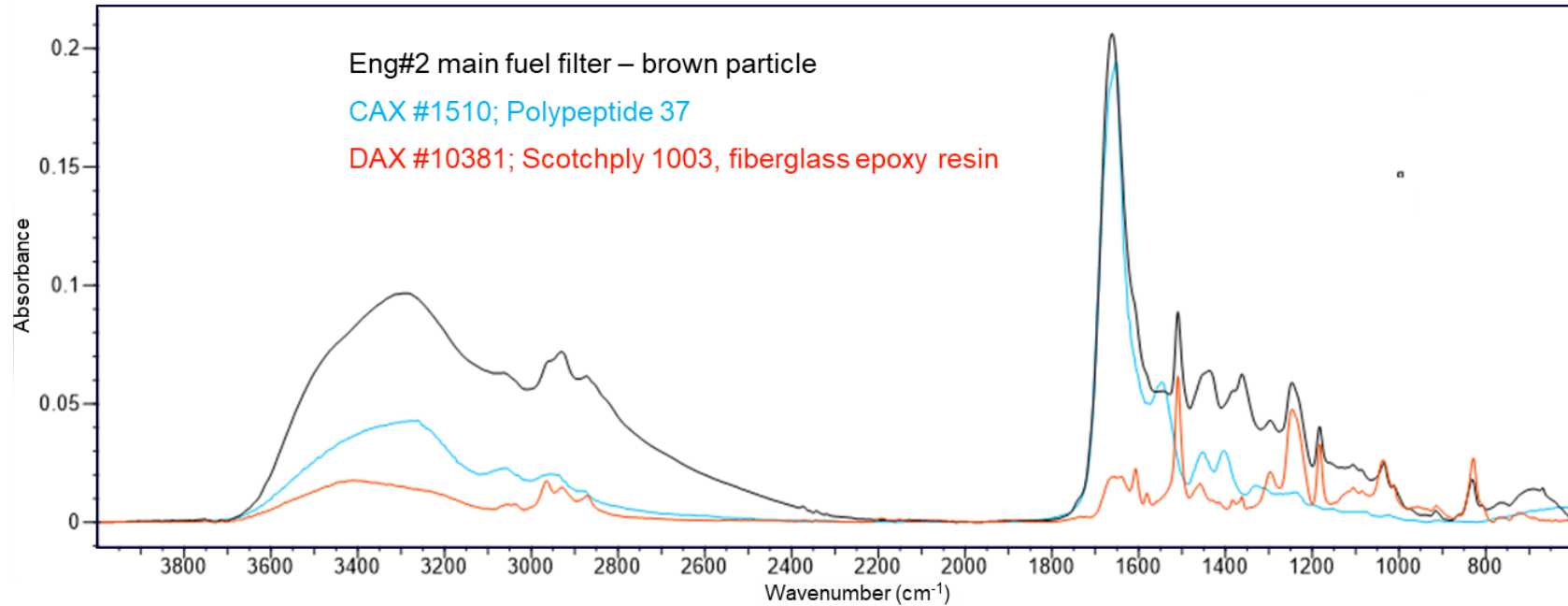
## Comparison to IR Spectral Database



Black particles were found on the surface of the 336048 Engine2 fuel filter. These black particles are a good match to the IR fingerprint of an **epoxy resin based on bisphenol A and epichlorohydrin**

# IR Spectroscopy of Solid Particles from 336048 Engine2 fuel filter

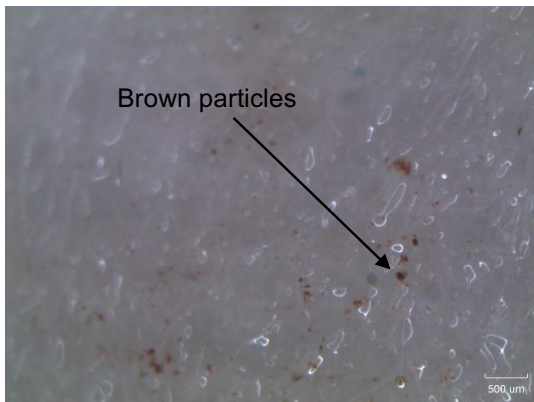
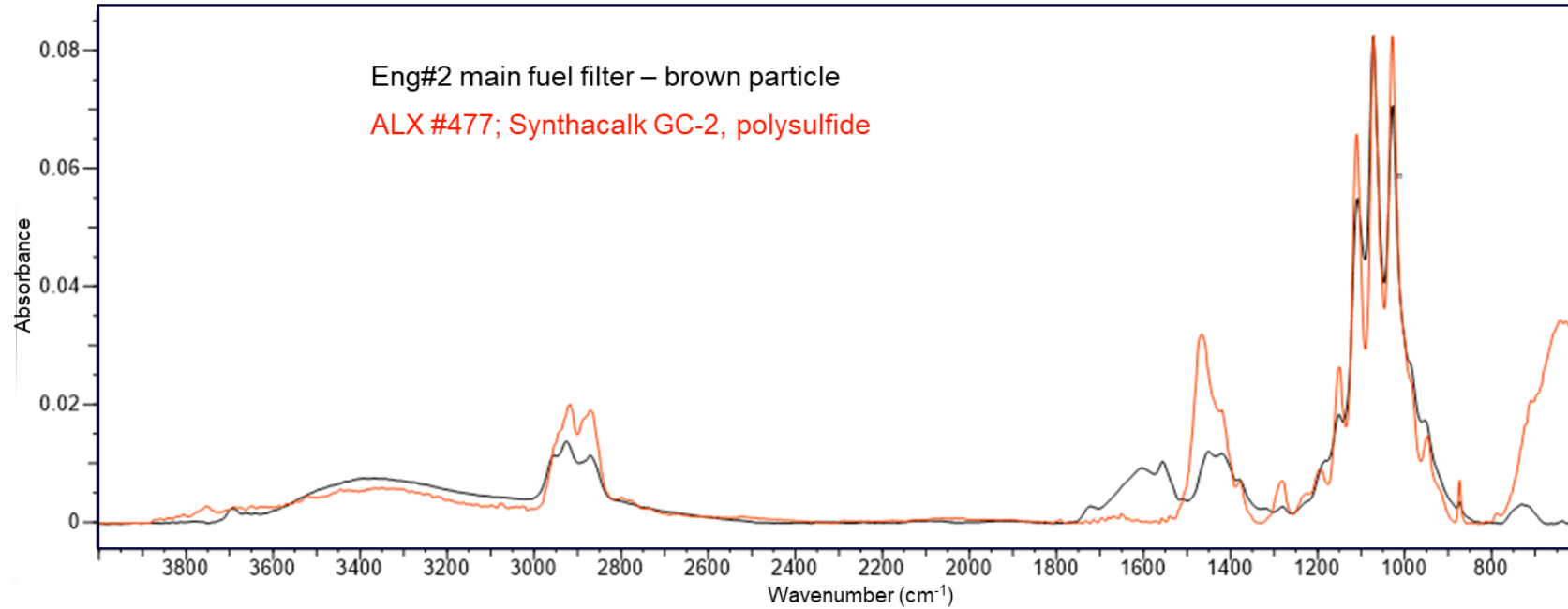
## Comparison to IR Spectral Database



Brown material on 336048 Engine2 fuel filter is a good match to the IR spectral features of **a mixture of a fiber glass epoxy resin and proteins**, likely from biological contamination.

# IR Spectroscopy of Solid Particles from 336048 Engine2 fuel filter

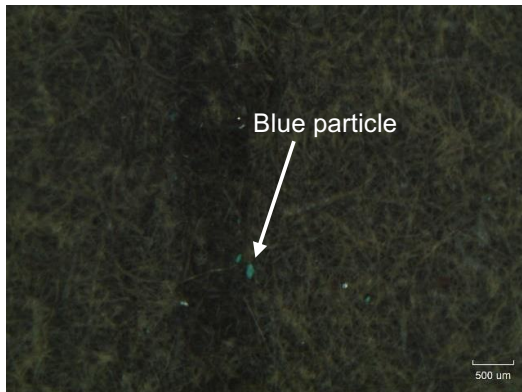
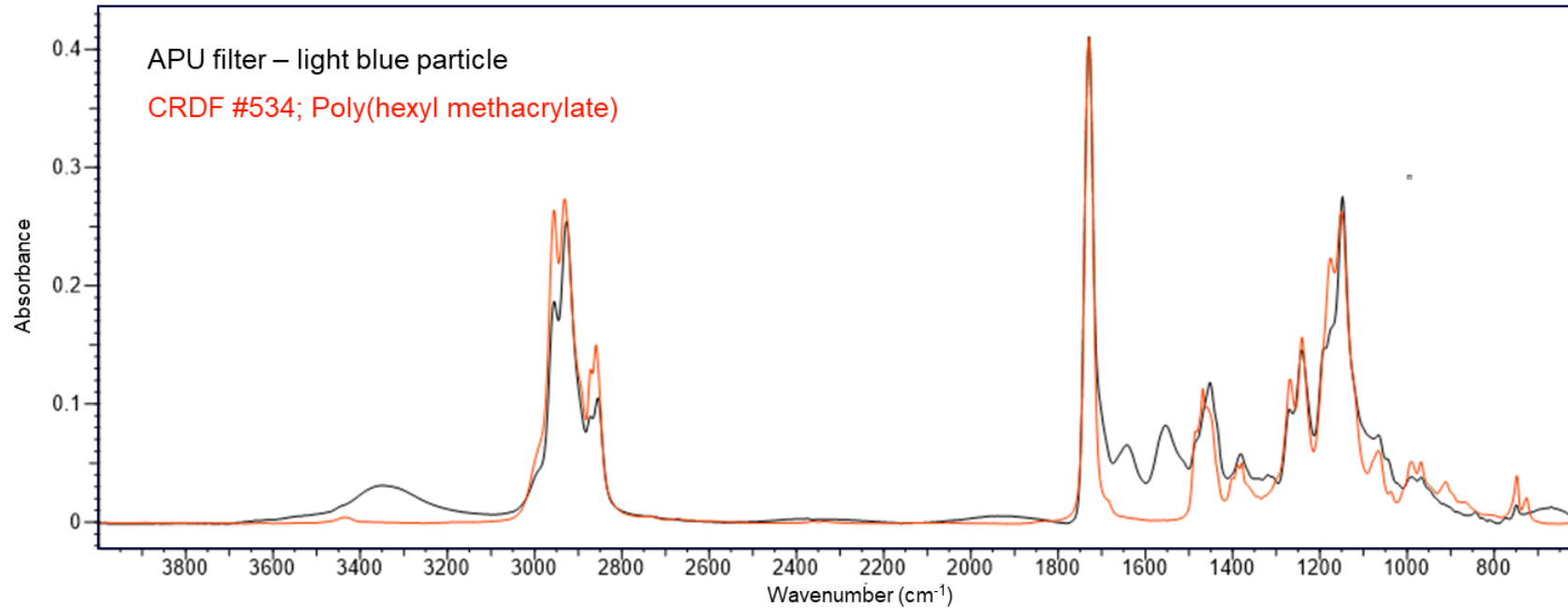
## Comparison to IR Spectral Database



Small brown particles on 336048 Engine2 fuel filter are a good match to the IR spectral features of a **polysulfide sealant**. Polysulfide sealant is often used in the fuel tank and pieces are commonly seen on the main fuel filter.

# IR Spectroscopy of Particles from 336049 APU Filter

## Comparison to IR Spectral Database

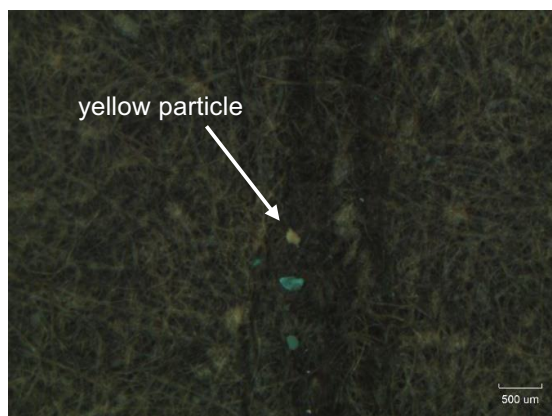
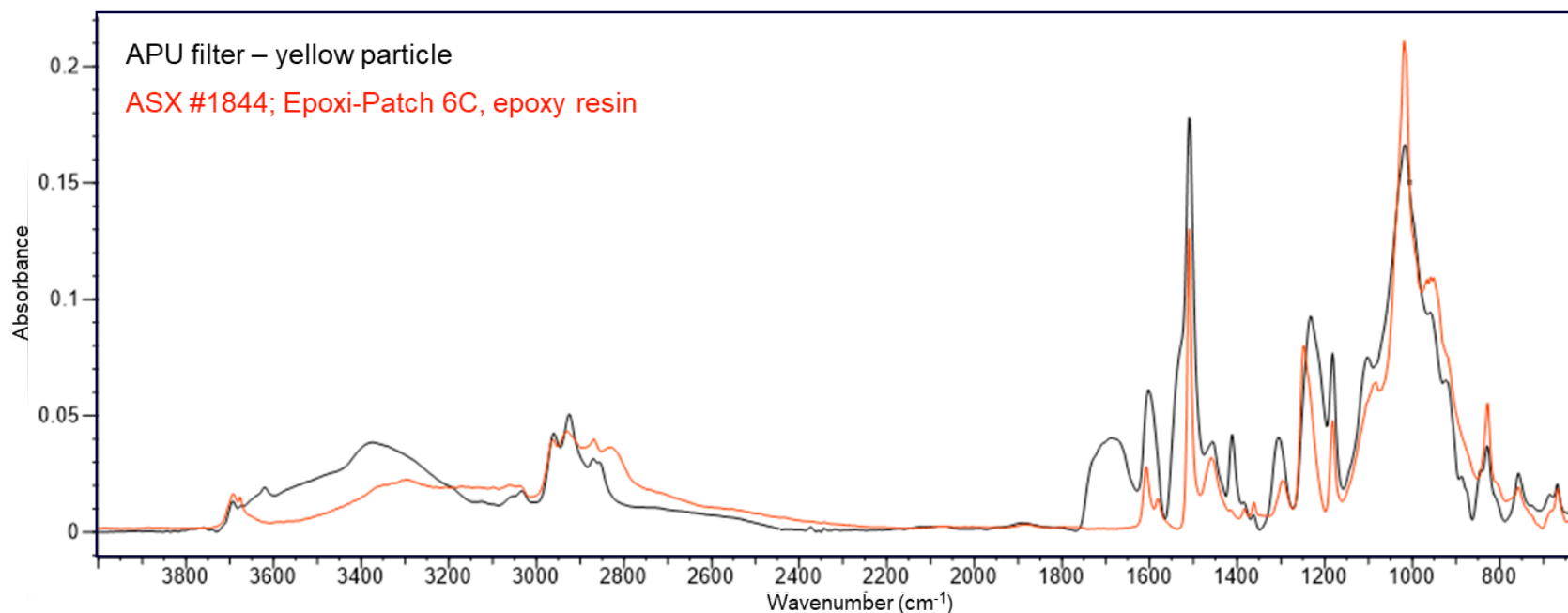


Pieces of blue material were numerous on the surface of the 336049 APU filter. These blue particles deposits are an excellent match to the IR fingerprint of a **poly(hexyl methacrylate)**

These light blue particles were the most common type of particles observed on the APU filter

# IR Spectroscopy of Particles from 336049 APU Filter

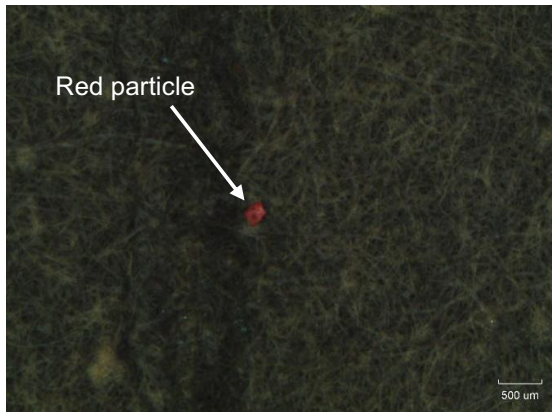
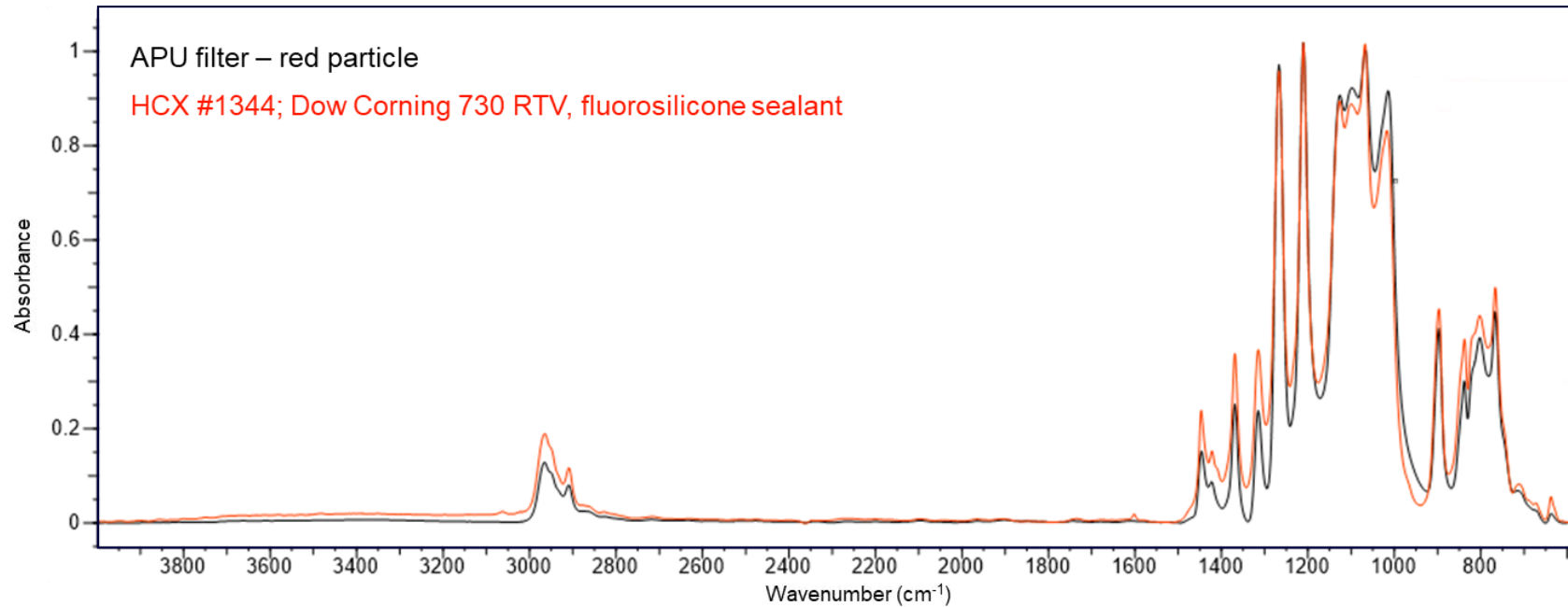
## Comparison to IR Spectral Database



Pieces of yellow material were found on the surface of the 336049 APU filter. These yellow particles are an excellent match to the IR fingerprint of an **epoxy resin** using an alkylamine linker.

# IR Spectroscopy of Particles from 336049 APU Filter

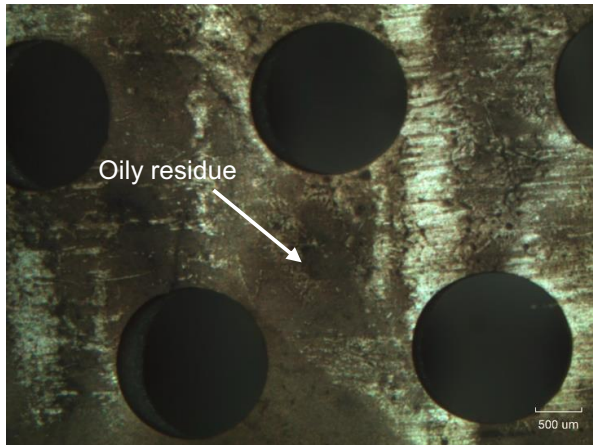
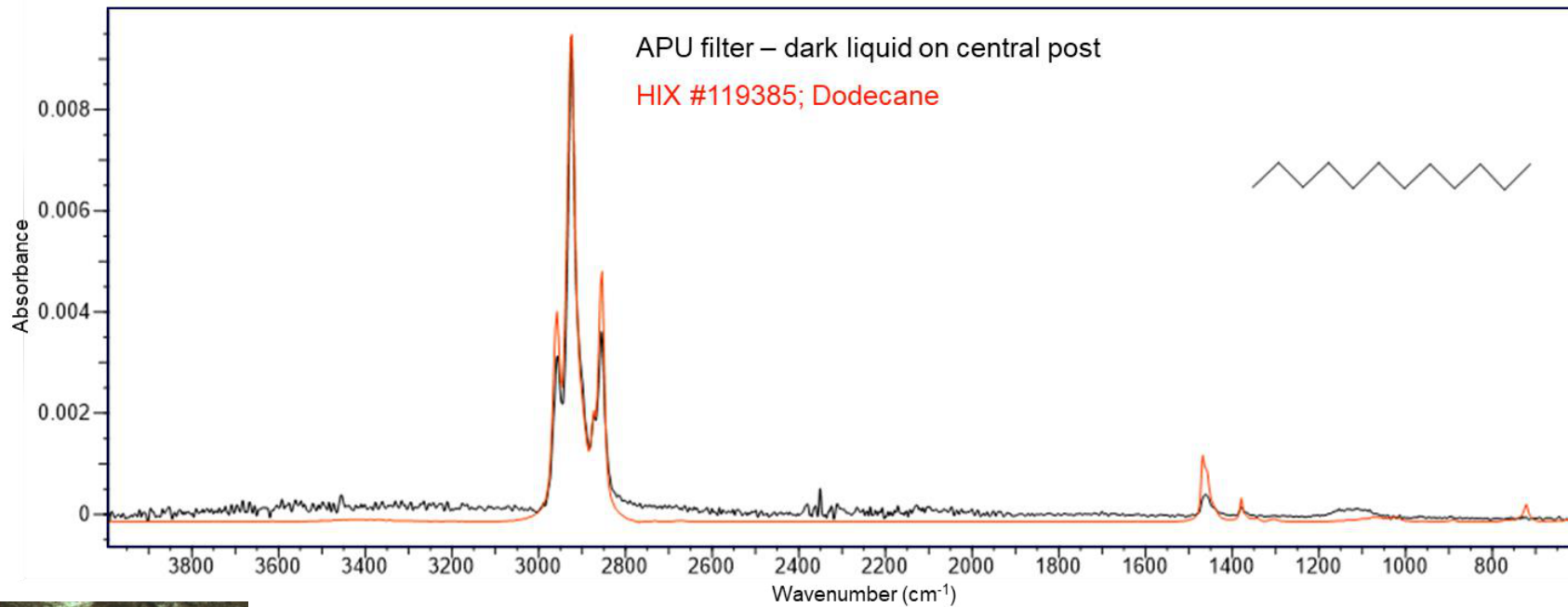
## Comparison to IR Spectral Database



Red chunks of pliable, soft material were found on the surface of the 336049 APU filter media. These red particles are an excellent match to the IR fingerprint of a **fluorosilicone sealant**. The same fluorosilicone particles were found on the main fuel filters.

# IR Spectroscopy of Liquid on 336049 APU Filter

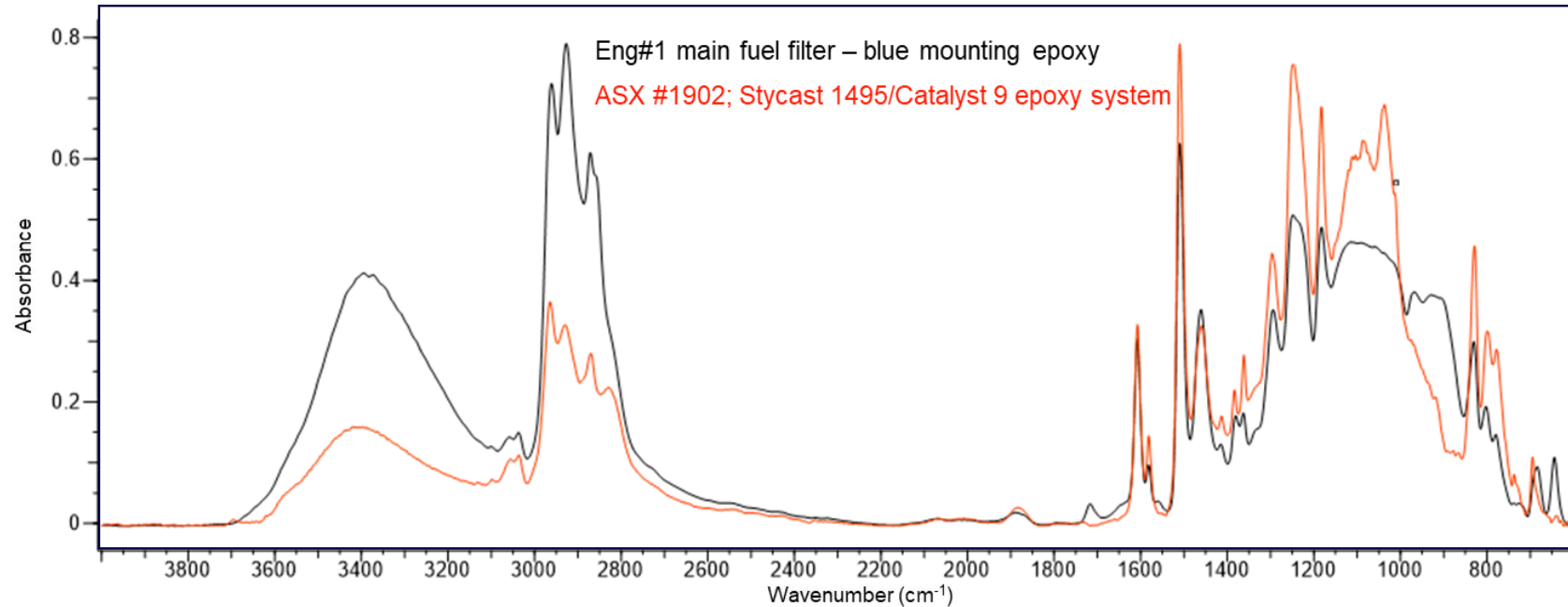
## Comparison to IR Spectral Database



The center post of the 336049 APU filter was coated with a dark liquid. This dark liquid was sampled and analyzed and shown to be **largely hydrocarbons**, a typical oil residue.

# IR Spectroscopy of Epoxy used to Assemble Main Fuel Filter

## Comparison to IR Spectral Database

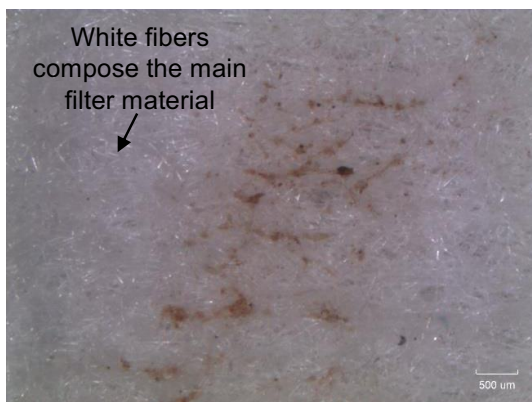
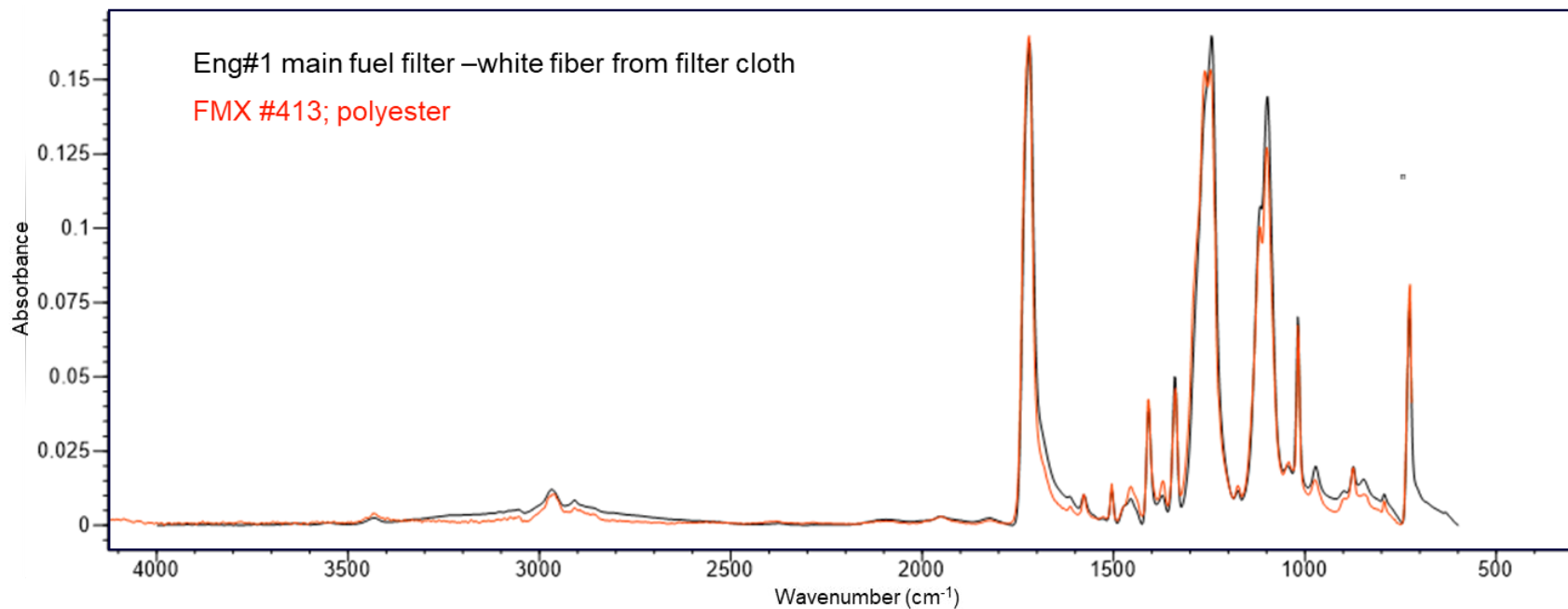


The blue epoxy used to affix the fuel filter end caps was also analyzed for comparison to the IR features of any recovered FOD.

Disassembling the filter yields a fair number of blue epoxy particles which need to be distinguished from the FOD

# IR Spectroscopy of Filter Media from Main Fuel Filter Eng#1

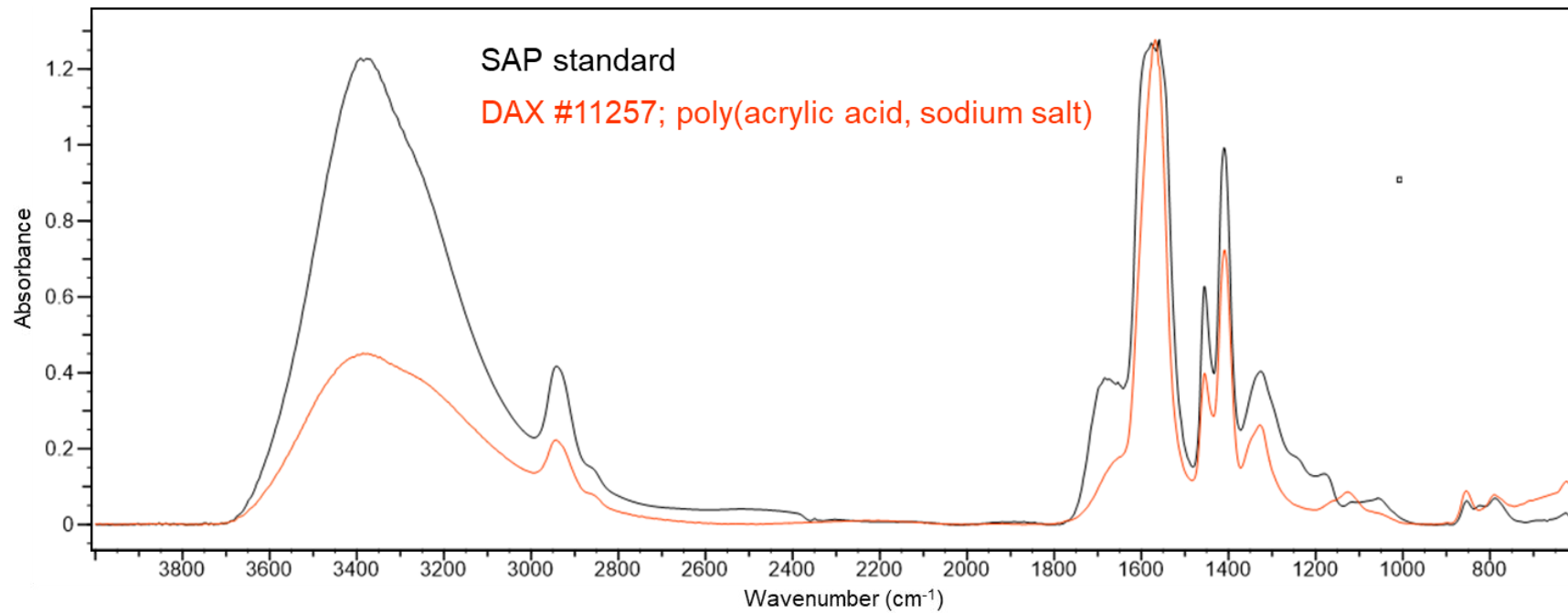
## Comparison to IR Spectral Database



The filter material was also analyzed for comparison to the IR features of any recovered FOD.

White fibers that compose the cloth filter layer are a good match to the IR spectral features of a **polyester**.

# IR Analysis of SAP Standard



The IR spectrum of SAP (super absorbent polymer) is shown here for comparison.

No signs of the SAP IR signature were found in these fuel and filter samples

## IR Spectroscopy Experimental Details:

Microscope - Solid (On Diamond Plate) - IR spectra were obtained with a Bruker Optics, Hyperion 3000 IR microscope attached to a Bruker Optics, Vertex 70 FTIR. The Hyperion 3000 is configured with a narrow-band MCT detector. For use with the microscope the associated bench is configured with a Ge on KBr beamsplitter. For this examination, a small particle of the sample was pressed between diamond plates. Then the plate with the sample was placed in the IR microscope and examined in transmission mode. A total of 128 interferograms were collected prior to the Fourier transform. A background spectrum was obtained by examining a sample free area in the field of view. Most spectra are baseline corrected to eliminate slopes and gentle curves. The region around 2100 wavenumbers may be obscured by the strong diamond absorbance in this region.

IR spectroscopy is generally only sensitive to bulk composition down to ~0.1-1% by weight for most common species. All metals and some metal oxides are not readily detectable by this technique.