

MATERIAL LABORATORY NOTES FOR MAGNET HOUSING AND FUEL

A small sample of an unknown brown substance was removed from the surface of the magnet holder from the accident aircraft. The unknown sample was examined using a Fourier Transform Infrared (FTIR) spectrometer with a diamond attenuated total reflectance (ATR) accessory in accordance with ASTM E1252-98 (American Society for Testing Materials E1252-98: Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis). The spectrometer was used to collect and process infrared wavelength absorbance spectrum of the unknown material.

The spectrum for the sample contained spectral peaks that corresponded to specific functional groups found within molecular structure of the material. The presence of a broad peak at $\sim 3372\text{ cm}^{-1}$ is indicative of an oxygen-hydrogen (O-H) bond. A triplet peak at $\sim 2947\text{ cm}^{-1}$, $\sim 2924\text{ cm}^{-1}$ and $\sim 2850\text{ cm}^{-1}$ corresponds to carbon-hydrogen (alkane) stretching bonds. A broad group of overlapping medium peaks at $\sim 1600\text{--}1530\text{ cm}^{-1}$ is likely indicative of a carbon-oxygen (C=O) double bond (carbonyl) (~ 1600) as well as carbon-hydrogen (C-H) bond deformation (~ 1530). A medium peak at $\sim 1481\text{ cm}^{-1}$ is indicative of a carbon-hydrogen (C-H₂) bending bond. Peaks at $\sim 1444\text{ cm}^{-1}$ and $\sim 11314\text{ cm}^{-1}$ are indicative of an oxygen-hydrogen (O-H) deformation bond. A peak at $\sim 1218\text{ cm}^{-1}$ is indicative of a carbon-carbon-oxygen-carbon stretching bond; a peak at $\sim 111\text{ cm}^{-1}$ is indicative of a carbon-oxygen single stretching bond. A single peak at $\sim 880\text{ cm}^{-1}$ is indicative of a carbon-oxygen bond. Weak peaks ~ 832 , 760 and 650 cm^{-1} are indicative of various carbon-hydrogen substituted bonds. This spectrum had several characteristics of a carboxylate ester.

The unknown spectrum was compared to a known spectrum for uncured Loctite® 271. The spectra did not match but there were several similarities particularly $\sim 2900\text{--}2800\text{ cm}^{-1}$ and $\sim 1500\text{--}1400\text{ cm}^{-1}$ areas. Despite not being a match, the differences in spectrum of the unknown material were likely a result of curing and aging/degradation of the material particularly the loss of spectral peak intensity in key function groups, peak shifts, and peak overlap.

While it wasn't an exact match to the adhesive that was sent (since that was an uncured sample), it appears that the brown residue is likely a similar material-some type of methacrylate ester or the actual material which had cured and aged. In addition, the orange material on the surface appears to be paint, which I understand was the marker that the work was completed.

A sample from the inside of the fitting from the accident magnet housing was collected for examination. A cut away of an exemplar magnet housing was provided by the manufacturer. On the exemplar, a sample from inside the fitting was collected as was a sample of material found on the outer surface of the housing. A dry sample of uncured Loctite was also collected. All samples were examined using a Fourier Transform Infrared (FTIR) spectrometer with a diamond attenuated total reflectance (ATR) accessory in accordance with ASTM E1252-98 (American Society for Testing Materials E1252-98: *Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis and American Society for Testing Materials*). The spectrometer was used to collect and process infrared wavelength absorbance spectra of the collected materials.

The spectrum from inside the fitting of the accident part was compared to the spectrum from the exemplar part. There was not a strong match between the two spectra however there were several similar peak combinations. This indicates that the material on the accident part was either a

similar material or a degraded sample of the exemplar material. A spectral library search was done on the accident spectrum and no other strong match was found.

The material found on the outside of the exemplar fitting was a strong match for the uncured Loctite sample. The uncured sample recovered from the outside of the exemplar fitting differed from the cured exemplar sample. This demonstrated the significant change the Loctite material underwent during curing. This change further supports that the accident material could be the appropriate material, just significantly degraded/aged.

Fuel

The best I can determine is that the yellow color likely came from the presence of the debris. Iron and copper can degrade the color of the dye as can heat and light. The spectroscopic analysis was consistent with avgas with the exception of the one set of peaks that may have come from a solvent or additive. I didn't see the any super-absorbent polymer (SAP) like the material in water removal filters used in fuel trucks in the spectrum. We would not be able to determine whether the debris could have clogged the fuel filter resulting in a power loss due to lack of fuel.