Barnett Technical Services

FTIR and Raman Spectroscopy as Non-Destructive Inspection Methods for Aerospace and other Industries

A wide range of non-destructive testing methods such as IR thermography or fluorescent penetration rely on the detection of light to measure a physical change in the material under inspection. FTIR (Fourier Transform Infrared) spectroscopy extends the use of light in the mid-infrared wavelength region to monitor chemical changes on the surface of a material that can affect the strength and/or performance of that material. Raman spectroscopy is an analogous analysis method that provides information on the chemical composition of a material on the surface of a structure. Both methods offer chemical information that is often not available by traditional NDT methods.

FTIR and Raman spectroscopy

IR thermography measurements involve the detection of light in the mid-infrared wavelength region as a result of the heat emitted from a component during or after operation. This measurement can provide physical information about the component such as inefficient operation or abnormal levels of friction, resulting in abnormal temperature elevations that produce an increase in light emitted in this wavelength region.

FTIR uses light in the mid-infrared wavelength region to obtain chemical information from a surface. Light in the mid-IR wavelength region illuminates a surface, and the FTIR system monitors light that is reflected off the surface. The chemical composition of the surface modifies the reflectance characteristics of the light at different wavelengths. An FTIR system can be used to provide a chemical signature of the material on the surface.

Raman spectroscopy is related to FTIR spectroscopy. In a Raman measurement, a surface is illuminated with a laser. The Raman spectrometer monitors light that is scattered off the surface. As with FTIR, the specific wavelengths of scattered light are related to the chemical composition of the surface.

Each technique offers advantages for specific applications, and the measurement can be tailored to be optimized to obtain the optimal results.

Thermal Exposure and Damage in Composite Materials

Composite materials can be damaged when exposed to excessive heat. Modern NDT technologies have difficulty in assessing this damage and the search for alternative NDT technologies is needed for these situations.

FTIR is able to monitors chemical changes that take place when a composite material is exposed to excessive heat. With appropriate surface preparation and standards, an estimate of the thermal exposure of a composite material (often with a correlation to the strength of the material) may be made. Based on these measurements, decisions can be made with regard to repair and/or replacement of regions that have been exposed to heat. This application has been demonstrated in both commercial and military aerospace applications.

Contamination Identification

FTIR and Raman spectroscopic methods provide information on the chemical composition of a material. In situations where an unknown material is found after operation of a device, these techniques can be used to identify the material and often, the cause of the failure can be identified. As an example, Figure 1 shows the FTIR spectrum obtained from a contaminant (red) with the reference spectrum from an FTIR database (blue).

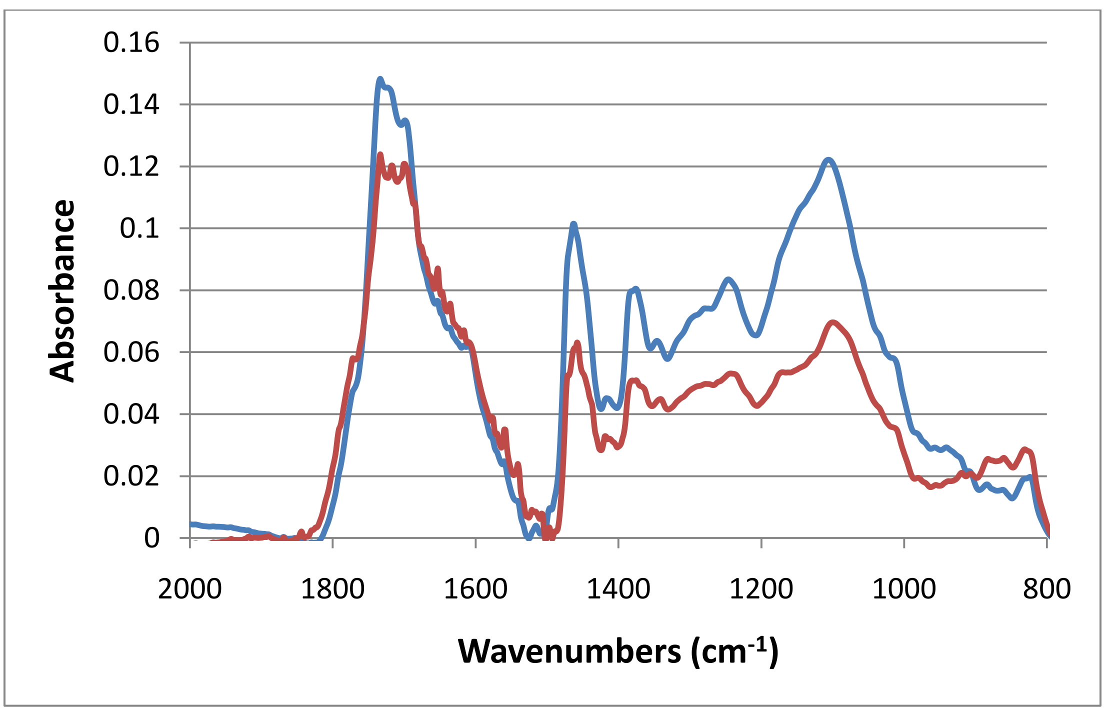

Figure 1. FTIR spectrum from an unknown contaminant (red) and the reference spectrum from an FTIR database of contaminants (blue).

Surface Preparation

In preparation for the application of protective coatings, a metallic surface needs to be thoroughly cleaned. Incomplete cleaning can lead to decreased lifetime of the coatings through delamination or other degradation of the applied coatings. FTIR spectroscopy can be used to verify the cleanliness of a metallic substrate in preparation for coating application, and valuable for the detection of contaminants such as silicone on a surface.

Coating Thickness

FTIR and Raman spectroscopy can be used for measuring the thickness of coatings on a surface. The chemical signatures measured by FTIR and Raman spectroscopy often permit the coating thickness to be measured in the presence of other coatings that are made up of different materials. Typical examples of this work include the thickness of primer coatings and the thickness of anodization coatings on metallic substrates.

Degree of Cure

FTIR and Raman spectroscopy provides information on the chemical bonding in a material. When a material undergoes curing, some chemical bonds are broken and others are formed. FTIR and Raman spectroscopy can be used to monitor these changes in chemical bonding, and can determine when a material is appropriately cured.

Composite ID for Recycling/Disposal

Composite materials may consist of a number of different resin systems. FTIR and Raman spectroscopy can be used to classify these different resins for recycling and disposal purposes.

Barnett Technical Services has extensive experience in the application of FTIR and Raman spectroscopy for these and other NDT applications. We offer consulting and training services for your measurement needs. For further information, please contact Barnett Technical Services:

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