OAK RIDGE NATIONAL LABORATORY
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FACT SHEET

Technologies for the Assessment of Heat Damage To Composite Materials and Structures

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One problem with polymeric matrix composites is their susceptibility to damage through thermal oxidative degradation due to exposure to temperatures above their recommended upper service temperatures. This exposure can be through fires, exposure to engine exhaust, lightning strikes, heating of nearby sections for repair, etc. Although this damage may be manifested in surface cracking, color changes, or other visual evidence, the damage may not be visually apparent at all. Even if damage is apparent, the extent of the damage in terms of property changes to the material is difficult to quantify. A number of "standard" inspection techniques have been evaluated over the last decade to determine applicability to the heat damage detection problem; only two techniques have been shown to have capability for reliably detecting and quantifying damage of this nature. These techniques as briefly described below have been developed by the Oak Ridge National Laboratory.

Diffuse Reflectance Infrared Fourier Transform (DRIFT)

- Infrared spectra is obtained by collecting and analyzing scattered light from the surface of a material.
- Spectra identifies and quantifies functional chemical groups present in the material.
- Comparison with spectra from degraded "standards" indicates degree of damage.

Laser Pumped Fluorescence (LPF)

- Ion lasers excite chemical compounds at surface of material being evaluated.
- Intensity and wavelength of re-emitted (fluoresced) energy is correlated to specific functional groups present.
- Comparison with spectra from degraded "standards" indicates degree of damage.

Advantages For Both

- Nondestructive and lightweight
- Rapid/real time assessments
- Low cost
- Field portable

Applications For Both

- Heat damage assessment
- Cure monitoring and characterization
- Environmental effects such as aging and durability

Prognostics Systems Applications

ORNL has demonstrated DRIFT and LPF capabilities in a variety of laboratory and field applications including actual evaluation of Harrier and A6 structures exposed to overtemperature conditions. It is envisioned that these techniques, along with a number of other technologies applied by ORNL organizations (fiber optics, thermal imaging, modal analysis, etc.), can be utilized to interrogate and evaluate the health of composite structures as part of a well defined prognostics program. In addition to in-depth knowledge of these advanced techniques, ORNL maintains very broad-based expertise in composite materials and structures available to assist with building a fully integrated system for capturing and analyzing data real-time to project system life expectancy.

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