



technology opportunity

# Improved Nondestructive Evaluation (NDE) of Advanced Nonmetallic Structural Composites

*Infrared (IR) contrast analysis and imaging augments and improves flash IR thermography*



Researchers at NASA's Johnson Space Center (JSC) have developed novel techniques for post-processing of flash IR thermography data, providing efficient and cost-effective enhancements to NDE of nonmetallic structural composites for myriad applications. Compatible with commercial IR thermography products, this suite of tools provides both quantitative and qualitative data analysis capabilities and reliable detection and characterization of anomalies in composite structures. Calibration techniques provide detailed, systematic analysis of flash thermography data comparable to that used in advanced pulse/echo ultrasonic testing, offering accuracy not currently available for NDE of composite materials.

## Benefits

- **Comprehensive:** Provides both quantitative and qualitative data about flaws
- **Detailed:** Offers accurate insights into defect shape, size, depth, and location
- **Competitive:** Provides the most precise and detailed characterization of flaws and anomalies
- **Cost-effective:** Lowers cost of implementation through hardware-system compatibility and ability to augment single-sided IR data processing methods
- **Accurate:** Improves flaw detection sensitivity with reflection correction
- **Efficient:** Extracts and constructs images quickly and simply, enabling swifter and more accurate evaluation of thermographic data
- **Easy to use:** Allows for analysis of data in a manner that is similar to pulse/echo ultrasonic testing, making it familiar to technicians

## Applications

This technology suite can be applied to any nonmetallic advanced structural composite used in myriad industries:

- Aerospace
  - Aircraft fuselage and structure
  - Airfoils
  - Turbine blades
- Power generation
  - Turbine blades
  - Pipelines
- Chemical and petrochemical
  - Pipelines
  - Fuel tanks
- Marine
  - Marine vehicle bodies
  - Fuel tanks
  - Pressure vessels
- High-performance automotive
  - Racecar bodies and structures
- Construction
  - Bridges

## Technology Details

Originally used by NASA for NDE of the Space Shuttle Orbiter, JSC's suite of IR contrast methods and tools help ensure the performance, functionality, and safety of composite structures.

### How It Works

The standard flash IR thermography setup (see Figure 1) houses the material being evaluated for flaws and directs a pulse of IR light onto it. The material's reflected thermal response generates an IR image. When a defect is present, heat flowing at the structure's front surface is impeded relative to the surrounding defect-free areas. Variations in the thermal diffusivity of the material manifest themselves as anomalies in the IR image of the test surface (see Figure 2).

Post-processing of the raw IR camera data provides highly detailed analysis of the size and characterization of anomalies, including both quantitative and qualitative information. Complementary contrast tools offer highly precise measurements:

- The peak contrast and peak contrast time profiles provide quantitative interpretation of the images, including detailed information about the size and shape of the anomalies.
- The persistence energy and persistence time profiles provide highly sensitive data giving indications of the worst areas of the detected anomalies.
- Peak contrast, peak time, persistence time, and persistence energy measurements also enable monitoring for flaw growth and signal response to flaw size analysis.
- The normalized temperature contrast profile provides more sensitive response than image contrast, allowing the system to detect smaller flaws.

### Why It Is Better

JSC's suite of software and tools offers a cost-effective and efficient way to provide more comprehensive, detailed, and accurate NDE detection and characterization of subsurface defects in nonmetallic composite materials than is possible with currently available commercial thermography software, which does not use image contrast or temperature contrast and therefore provides less accurate characterization of defects. Furthermore, because JSC's software normalizes and calibrates data, it provides more stable measurements and greatly minimizes errors due to operator and camera variability.

### Patents

NASA has received one patent for this suite of technologies (U.S. Patent No. 8,577,120) and has a second patent pending.

### Licensing and Partnering Opportunities

This suite of technologies is being made available through JSC's Technology Transfer and Commercialization Office, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to

consider licensing the flash IR thermography suite of software and tools (MSC-24444-1 and MSC-24506-1) for commercial applications.

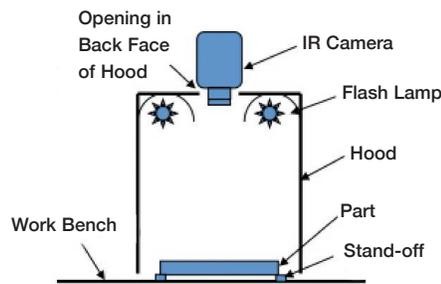


Figure 1. Flash IR thermography schematic

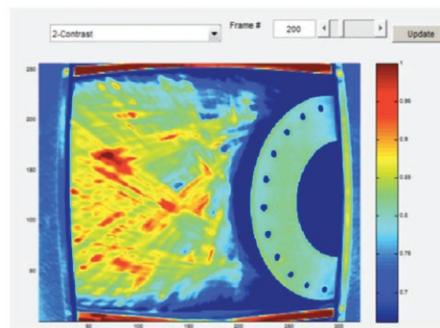


Figure 2. A normalized contrast image, showing areas of delamination and voids in red.

### For More Information

For more information about technology licensing and partnering opportunities, please visit:

**Technology Transfer and Commercialization Office**  
**NASA's Johnson Space Center**  
**Phone: 281-483-3809**  
**E-mail: [jsc-techtran@mail.nasa.gov](mailto:jsc-techtran@mail.nasa.gov)**  
**Web: <http://technology.jsc.nasa.gov>**