APPLICATION NOTE

High resolution infrared cameras provide enhanced thermal detail for R&D applications

Whether you're designing or testing printed circuit board prototypes, developing new products or new product materials, or analyzing laminar flow patterns on an aerodynamic design, thermal imaging plays a key role. Analyzing characteristics such as temperature, heat dissipation, latent heat, and other heat-related material properties can reveal countless potential problems at an early stage in the development process to help ensure quality and avoid failures downstream. The technology has the potential to provide valuable insight into a wide range of applications from materials analysis to component design to controlled chemical reactions.

Infrared cameras (also called thermal imagers) are ideal tools for both scientific research, and early and late stage development troubleshooting and analysis, because they collect thermal data without physically contacting the target and without interfering with the process. Understanding what is really occurring in any situation often depends on the proper understanding and control of variables that may affect the material or device under test. Using a non-contact infrared camera to document and measure the performance or changes in thermodynamic properties of the object under test often eliminates variations that might be introduced by a contact temperature device such as an RTD or other contact temperature probe.

Furthermore, far more simultaneous data points can be collected with an infrared camera than physical sensors could ever possibly collect. These simultaneous data points combine to form a detailed, false-color picture of the heat patterns at any point in time. This is invaluable to engineers and scientists, who understand the fundamentals of thermodynamics and heat flow, and have specific knowledge of the material or design under test.

Get the detail and accuracy you need.

R&D infrared inspection and analysis covers a wide range of applications, from identifying thermal anomalies in circuit board components, to tracking phase changes in injection mold manufacturing, to analyzing non-destructive testing of multilayer composites or carbon fiber components. While the specifics of those applications vary tremendously, all benefit from infrared cameras with a high

Top SIX

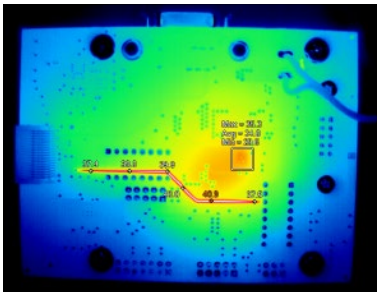
R&D application areas for these Expert Series thermal imagers

1. Electronics research and development
2. Materials engineering
3. Chemistry and biological sciences
4. Product design and validation
5. Geothermal, geological and earth sciences
6. Aerodynamics and aeronautics

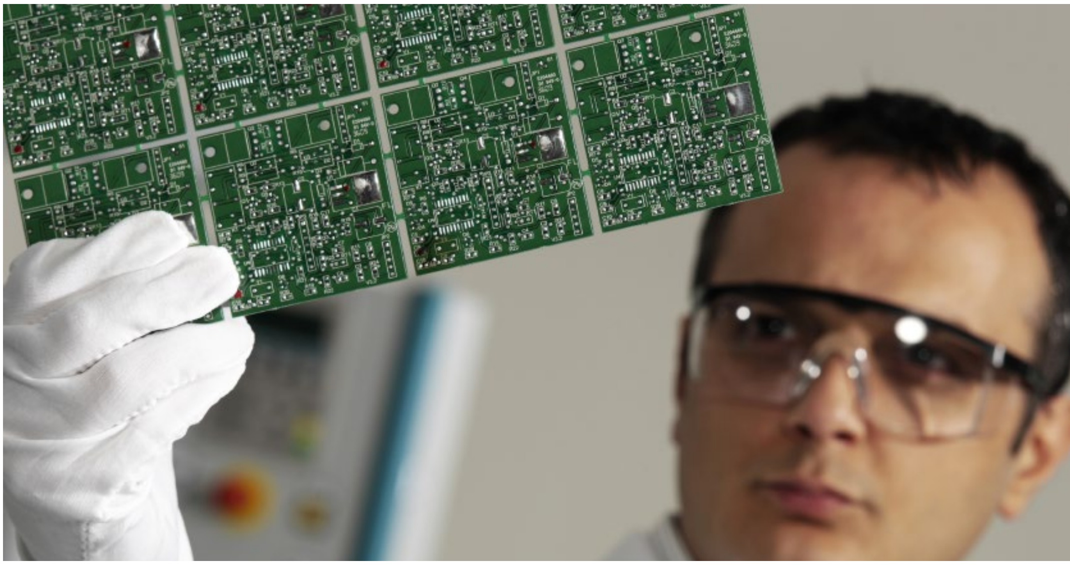
degree of accuracy, excellent spatial and measurement resolution, high thermal sensitivity, and responsive performance.

Fluke offers infrared cameras that provide all of these capabilities with a versatile set of features that are indispensable for many types of R&D applications. High resolution coupled with optional macro lenses can provide for up-close imaging capabilities that produce highly detailed and informative images, with apparent temperature calculations for each pixel. Individual images can provide a wealth of data on their own. Capture multiple images, or streaming radiometric data, and the mountain of data increases exponentially. All who take on the task of research and development will appreciate useable, accurate, and analyzable data. Users can easily access this data from the included SmartView® software and then often export it and apply their own analysis and algorithms.

The extremely high thermal sensitivity of these infrared cameras combined with the unprecedented spatial resolution allow for radiant analysis not previously possible with most commercially-available products. This allows for a more thorough and accurate analysis of various material properties.



Thermal evaluation of PCB layout for areas of potential concern



Top Six application types

Electronics research and development

- Finding localized over-temperature issues
- Characterizing the thermal performance of components, conductors and semi-conductor substrates
- Establishing appropriate cycle times
- Analyzing assembly impact
- Validating thermal modeling projections
- Assessing collateral damage due to proximate sources of heat

Materials engineering

- Phase change analysis
- Residual or repeated thermal stress analysis
- Non-destructive testing including inspection and analysis of delamination, voids, moisture inclusion, and stress fracturing of composite materials
- Surface radiance analysis

Chemistry and biological sciences

- Monitoring exothermic and endothermic chemical reactions
- Analyzing biological processes
- Environmental impact monitoring and analysis
- Plant and vegetation research

Product design and validation

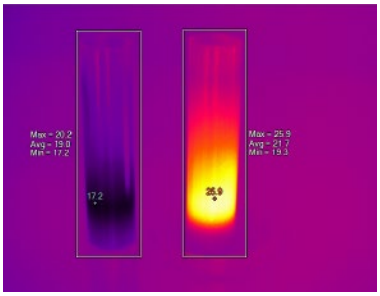
- Characterization of product thermal performance
- Characterization of material properties in a product
- High-speed monitoring and analysis of product thermal performance

Geothermal, geological, and earth sciences

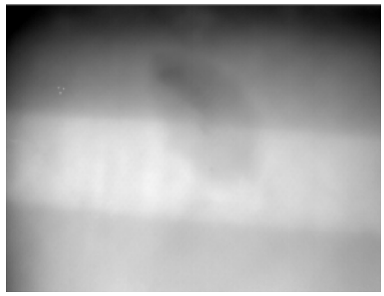
- Monitoring and analysis of geothermal formations and processes
- Volcanic research

Aerodynamics and aeronautics

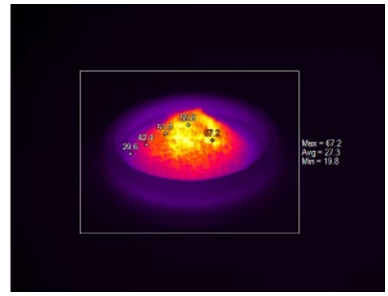
- Characterization and analysis of laminar flow
- NDT of composite materials and structures
- Stress and deformation analysis
- Propulsion system performance analysis



Thermal comparison between a controlled endothermic chemical reaction (left) and a controlled exothermic chemical reaction (right)



Area of delamination and multiple pin-hole penetrations on a rotary wing aircraft blade



Evaluation of solid oxidation-type compound used in personal hand-warmers

A few examples of adding value with infrared inspection

Analyzing printed circuit boards

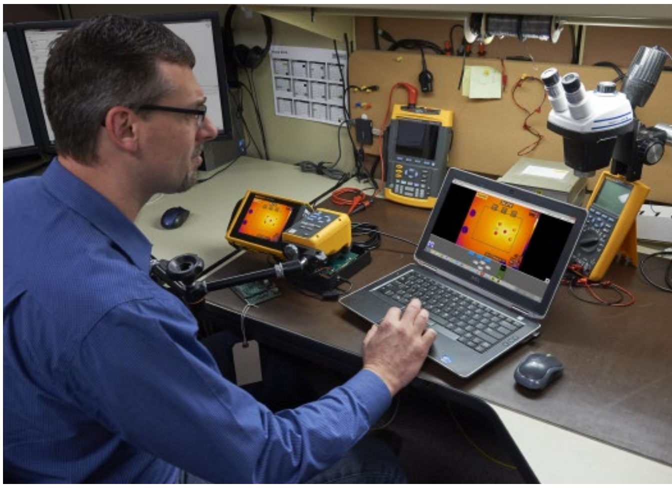
- **Finding localized over-temperature issues.** Design engineers have to combine heat intensive solid-state high power transformers, high speed microprocessors, and Analog to Digital (A/D) or Digital to Analog (D/A) signal convertors into a very small package.
- **Establishing cycle times.** Set the infrared camera to record thermal measurements as a solder point cools, so that you can set cycle times for automated systems. You can annotate key points with voice and text for quick review.
- **Analyzing assembly impact.** Perform quality review at various stages of the development and manufacturing processes to ensure that any issues are captured early to avoid costly component failures down the road.
- **Validating thermal modeling.** Using thermal modeling software provides a good estimate of what will occur when you populate a board, but it's still only a simulation. You can easily validate those results by comparing your thermal CAD model to what you're actually getting with the camera as you populate the board and power up components. Then you can scan the finished powered-up prototype and compare the results to your model to see how close it is.
- **Assessing collateral damage.** Sometimes heat from the circuit board can affect the performance of other components in the system, such as making an LCD run too hot or interfering with mechanical operation. To avoid that you can assess how much heat dissipates from the entire package and how that heat may affect other parts of the system. Start by capturing an image of the powered up unit with the cover on. That image shows the temperatures of all the components under power. Then remove the cover and do a radiometric video recording of the temperature decay curve. You can then export a group of maximum temperature points into spreadsheet software and backwards extrapolate the resulting curve to time zero, to see what the temperature of the component was before you took the cover off.

Materials engineering

- **Phase change analysis.** Changing the phase of a product—from solid to liquid, often takes a great deal of heat, while changing from liquid to solid results in releasing an excessive amount of latent heat. If that extra heat has not been accounted for in the phase change process, it can result in warped parts. That is caused by the material staying liquid for longer than expected while heat is still evolving from the part, causing it to warp. Tracking the phase change process with a infrared camera will give you a precise picture of how long that phase change will take and you can adjust the heat application accordingly.
- **Residual thermal stress** can either strengthen a product or can result in warping or breakage due to a problem with the materials or the heating and cooling process. Using a camera to analyze the actual production process compared to the thermal model can help identify variances that may impact product quality.

Fluke infrared cameras let you view small components and their connection points to locate hot spots and analyze the effects of the heat on other components.

- **Non-destructive composite component testing.** Scanning composite components with a high resolution infrared camera can reveal hidden defects such as cracks, voids, delamination, and disbonding.
- **Radiant analysis.** The extremely high thermal sensitivity and unprecedented spatial resolution of Fluke infrared cameras allow for more thorough and accurate radiant analysis not previously possible with most commercially-available products.

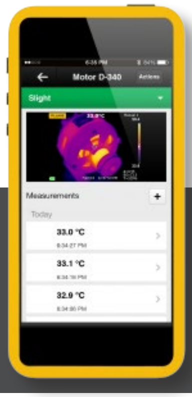


Keep your development process on track with Fluke infrared cameras

Don't let an inability to understand and quantify thermal issues slow down your research or product development. Fluke infrared cameras provide a high level of detail to help you find and document thermal issues quickly*:

- **High resolution.** Get four times the standard mode resolution and pixels (up to 3.1 million pixels on the TiX1000 and up to 1.2 million pixels with the TiX660) with Super-Resolution mode and viewed in SmartView® software for crisp images that deliver maximum detail.
- **Different display options** with hand-held infrared cameras that come with a 240 degree, 5.6 inch rotating screen, or mounted infrared cameras meant to continuously stream data to your computer
- **Advanced, versatile focus options** for quick, accurate, in-focus image capture can save you time and provide better detail so you can monitor subtle changes.
- **Maximum lens flexibility** with easy-to-switch lens options, including macro, telephoto and wide-angle lenses, allow you to capture high-resolution images.
- **Real-time radiometric recording** with voice and text annotations makes it easier to identify points that require closer examination and allows for frame-by-frame analysis of thermal processes and changes.
- **Differences (Subtraction) comparison** allows you to establish a baseline state and then see and analyze the thermal differences that occur after that point in time.
- **Subwindowing option to detect sudden changes with high-speed infrared imaging** (selectable camera option at time of camera purchase). This allows you to document and analyze many frames of data per second to better understand sudden temperature changes.
- **Extensive temperature range,** from -40 °C to 2000 °C (-40 °F to 3632 °F) accommodates inspections that require extreme heat conditions.
- **Live data viewing and analysis on a PC.** Use the included SmartView software to optimize and analyze images and create inspection reports. You can also export results into spreadsheet format for further, more detailed analysis and alternate data presentation.
- **Built-in MATLAB® and LabVIEW® toolboxes** to easily link infrared data into the softwares that R&D professionals use everyday

*Not all features are available on all Fluke infrared camera models. Please check your local Fluke website or speak to your local Fluke representative for more information on camera-specific specifications.



FLUKE CONNECT®

Multiply your resources with Fluke Connect® wireless capabilities[1]

With the Fluke Connect mobile app you can transmit images and measurements from Fluke infrared cameras in real-time to authorized smart phones or tablets that have the Fluke Connect mobile app. You can also share results instantly with team members to enhance collaboration and resolve issues faster. With Fluke Connect® Assets, you can also associate images to assets, see your images and other measurements by asset in one place, and generate reports that include other measurement types. See **www.flukeconnect.com** for more information.

[1]Within your provider's wireless service area; Fluke Connect® and Fluke Connect® Assets are not available in all countries. Smart phone not included with purchase.

See what you're missing

Whether you're designing the next mobile device, scaling down passenger vehicles, or developing a new stronger, lighter polymer, make sure you have the best thermal data you can get. The Fluke infrared cameras deliver the image resolution, temperature detail and accuracy, speed, and flexibility to help you succeed.

To find out more about how these versatile, high resolution, high accuracy cameras can help you develop better products faster, consult your Fluke sales representative or visit **www.fluke.com/infrared** for more information.

Fluke. *Keeping your world up and running.®*

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