APPLICATION STORY

FLIR CAMERAS REVEAL THERMAL CHARACTERISTICS OF MICROELECTRONIC DEVICES

The FLIR A6703sc is ideal for capturing high-speed thermal events and fast-moving targets.

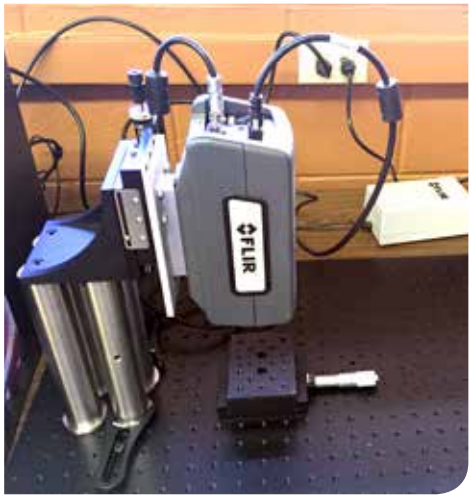
In the development of electronic and microelectronic devices, transient thermal information is critical to validate whether a device or a specific part of the device is operating properly. What's more, the performance of next generation of microelectronic devices will depend on a better understanding of the thermophysical properties of the various materials used in the microelectronics. At the University of Texas at Arlington, the team of Dr. Ankur Jain, who heads the Microscale Thermophysics Laboratory, studies a wide range of topics related to microscale thermal transport. The laboratory makes use of diverse modern equipment and instruments, including thermal imaging cameras from FLIR Systems.

Miniaturization has been a key development in the microelectronics industry for the past several decades. Smaller devices can offer faster operational speeds and more compact systems. Advances in nanotechnology and thin-film processing have spread to a wide range of technological areas, including photovoltaic cells, thermoelectric materials, and micro-electromechanical systems (MEMS).

The thermal properties of these materials and devices are of critical importance for the continued development of such engineering systems. However, a number of concerns related to thermal transport exist in these systems. In order to efficiently address these concerns, it is critical to fully understand the nature of thermal transport in materials at the microscale.

HEAT DISSIPATION IN 3D ICs

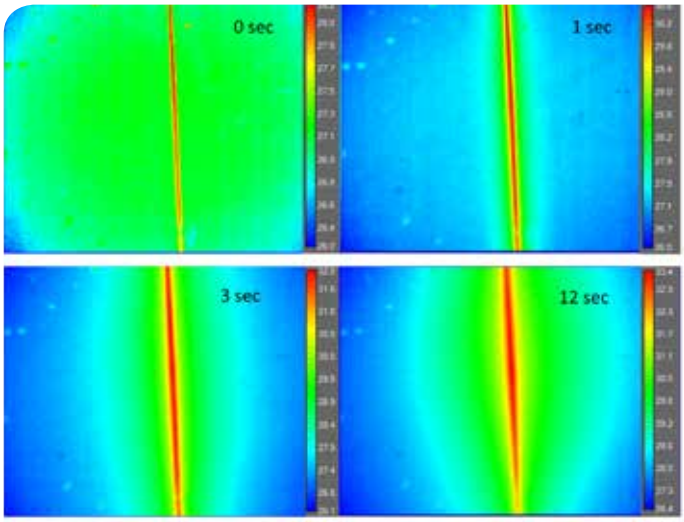
Dr. Ankur Jain directs the Microscale Thermophysics Laboratory, where he and his students conduct research on microscale thermal transport, energy conversion systems, semiconductor thermal management, bioheat transfer and related topics. Heat dissipation in three-dimensional integrated circuits (ICs) is a significant technological challenge, and has impeded the wide adoption of this technology despite a tremendous amount of research in past decade or two. Researchers at the Microscale Thermophysics Laboratory are therefore carrying out experiments to measure key thermal characteristics of 3D ICs and are developing analytical models to understand thermal transport in a 3D IC.



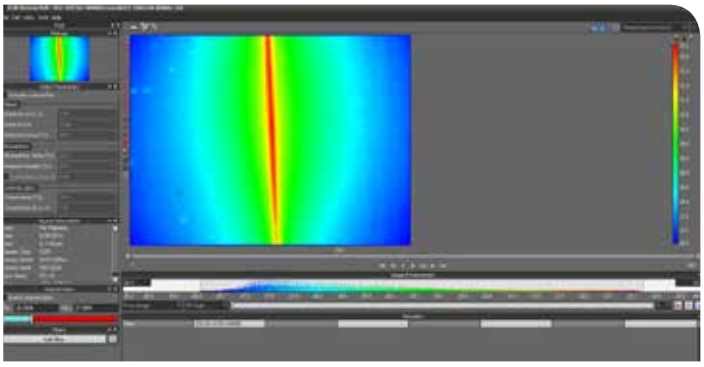
In a typical test experiment, microheater lines on a substrate are connected to a power source. The device is heated up through Joule heating. Thus, the temperature field of the substrate evolves as a function of time.

MEASURING TEMPERATURE FIELDS

Thin film materials have been an essential feature of microelectronics ever since its inception, serving a variety of functions on the chip. In order to precisely understand the thermal behavior of thin films, we need to be able to correlate thermal properties



Ankur Jain: "We are especially interested in the evolution in time of a temperature field on a micro-device. By measuring the thermal properties of the substrate, we try to understand the fundamental nature of microscale heat transfer."



Ankur Jain: "The ResearchIR software from FLIR has greatly improved collaboration inside our team as well as between our and other teams."

with the evolving microstructure and morphology related to the deposition process. This way, it should be possible to investigate properties such as conductivity, bulk modulus, thickness, and thermal boundary resistances.

"We are especially interested in the evolution in time of a temperature field on a micro-device," says Dr. Ankur Jain. "By measuring the thermal properties of the substrate, we try to understand the fundamental nature of microscale heat transfer."

In electronics, heat is often an undesirable side effect of the primary device function. Thus, it is important to fully understand transient thermal phenomena in thin films. "By learning how the heat flows in a microsystem, we can efficiently minimize overheating issues. This helps us to design better microsystems and to make more intelligent choices in terms of materials. For example, we have carried out a study to compare the thermal transport properties of various types of thin films."

Ankur Jain. "By measuring the thermal properties of the substrate of a microdevice, we try to understand the fundamental nature of microscale heat transfer."

"In a typical test experiment, we connect microheater lines on a substrate to a power source. By supplying a very small amount of current, we heat up the device through Joule heating. Thus, the temperature field of the substrate evolves as a function of time."

THERMAL IMAGING CAMERAS

To measure the temperature on microelectronic devices, the team of Dr. Ankur Jain has used a wide variety of techniques, including thermocouples. A main challenge with this technique is that thermocouples only measure temperature values at a single point. For a more complete and visual picture of the temperature field, Dr. Jain decided to use thermal imaging cameras from FLIR.

The FLIR A6703sc thermal imaging camera has been designed for electronics inspections, medical thermography, manufacturing monitoring, and non-destructive testing. The camera is ideal for capturing high-speed thermal events and fast-moving targets. Short exposure times allow users to freeze motion and achieve accurate temperature measurements. The camera's image output can be windowed to increase frame rates to 480 frames per second to accurately characterize even higher speed thermal events, helping ensure critical data doesn't get missed during testing.

"Thermal phenomena in devices of interest to us occur very rapidly, and we need full field information as opposed to single-point measurements," says Dr. Ankur Jain. "The FLIR A6703sc has helped us during our experiments, because the camera presents us with very fine details of the device being measured."

THERMAL ANALYSIS SOFTWARE FOR RESEARCH AND SCIENCE APPLICATIONS

The team of Dr. Ankur Jain has also been using FLIR's ResearchIR analysis software for research and science applications. ResearchIR is a powerful and easy-to-use thermal analysis software package for camera system command and control, high speed data recording, real-time or playback analysis, and reporting.

"The ResearchIR software from FLIR has proven to be very useful in our team," says Dr. Ankur Jain. "Especially the ability to save our thermal recordings and then share them across several PCs for further analysis has been very useful. ResearchIR has greatly improved collaboration inside our team as well as between our and other teams."

For more information about thermal imaging cameras or about this application, please visit:

www.flir.com/research