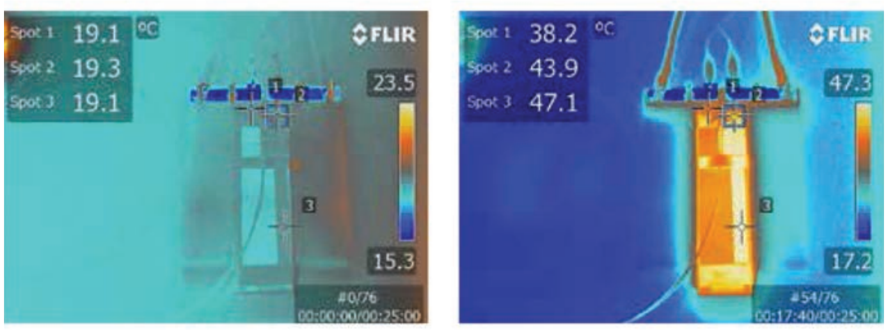
Thermal Imaging Helps to Build High-Performance Electrical Racing Car

FLIR Systems

Every year, engineering students from around the world are challenged to design and build a single-seat racing car in order to demonstrate their knowledge and talent. In a worldwide competition, called Formula Student, this racing car is then put to the test in static and dynamic events, which test the performance of the vehicle. Mechanical engineering never gets more exciting than this. The Technical University of Delft in the Netherlands (TU Delft) has been participating in the Formula Student competition since 2001. Again in 2014, TU Delft's DUT Racing team is aiming at designing the most efficient and high-performance electrical racing car, this time with the help of thermal imaging cameras.

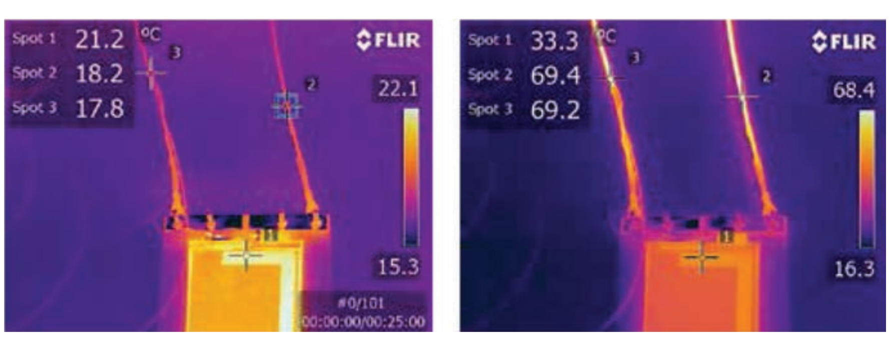


The FLIR T640 is used to detect hot spots of battery cells with different load cases.

Formula Student aims to inspire and develop enterprising and innovative young engineers. This high-performance engineering project is not only extremely valued by colleges and universities worldwide, it is also viewed by the motorsport industry as the standard for engineering graduates to meet, transitioning them from university to the workplace. Formula Student started back in 1981 in the US and came to Europe in 1998. TU Delft participated for the first time in 2001 and even allows students to choose Formula Student as a minor. Today, the Formula Student competition is joined by over 500 teams. The DUT Racing team now consists of 80 people, of which seven full-timers and fifteen minor students.

Monitoring a battery cell for hot spots.

Students of the DUT Racing team are housed at the impressive D:DREAM hall at the Delft University campus and they can make use of the most advanced technologies out there to design their racing car. One of these technologies is thermal imaging. When designing an electrical car, it can be important to monitor temperatures in real time. In the case of DUT Racing team, a thermal imaging camera from FLIR Systems is used to check for hot spots in battery cells, monitor the temperature profile of car tires and test car electronics.

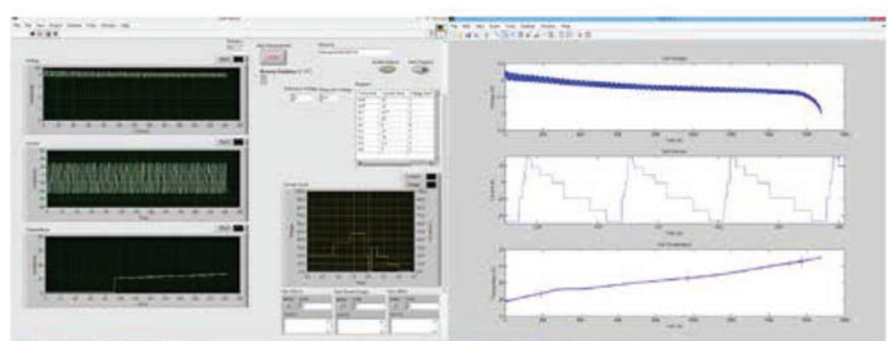


Cables with a low current rating are put to the test. If approved for use, these cables will contribute to keeping the weight of the car low.

Lightweight Components

One of the major issues that the Delft team is famous for is making lightweight vehicles. With the DUT cars, every unnecessary gram is removed in the design stage. This lightweight design philosophy, which is known as 'the Delft concept' has resulted in impressive figures. The 2013 DUT car weighs 175 kg and for 2014, the DUT racing team is aiming for 155 kg. Many competing teams are struggling to build cars even below 200 kg.

The attention to weight applies to almost every car component. "In the case of car batteries, the more energy – Joules – you require, the more weight you will need," said Bauke Kooger, Chief Accumulator at the DUT Racing team. "We use a FLIR T640 thermal imaging camera to monitor the temperature and detect hot spots of battery cells with different load cases. To this end, we simulate cycles that are typical of an endurance race, which is part of the competition's dynamic tests. This way, we want to be able to see where we need to place the temperature sensors and how we need to size the cooling system. Also, the FLIR thermal imaging camera allows us to see hot spots located at bad connections in an assembled accumulator."



Graphical report of a test cycle of a battery cell test, where temperature values are set out against current and voltage values.

Even cables are tested. During a current test, the DUT team is checking whether using a cable with a lower cable current rating is detrimental for the performance of the car. If not, it would allow the team to user even lighter cables.

The weight issue also applies to the car tires, as wider tires will provide more grip, but will also be heavier. "We design the tires ourselves," said Marinus Geuze, Chief Electronics at the Delft Formula Student team. "With the FLIR thermal imaging camera, we can monitor the temperature profile of the tire.

A uniform temperature across the full tire surface is very important in terms of performance. With the temperature information we receive from the thermal imaging camera, we can adjust the suspension of the car."

Thermal Imaging in any Design Stage

The use of thermal imaging does not stop with monitoring tires and battery cells. "If we are looking at the entire one-year design and development process of the DUT racing car, there are few moments where thermal imaging cameras will not be useful,"

The current DUT car weighs 175 kg, whereas many competing teams are struggling to build cars even below 200 kg.

said Marinus Geuze. "We also want to use thermal imaging to test our printed circuit boards and see which components get hot when in operation. This way we can adapt the design if necessary prevent problems before the final print board gets integrated into the car. We also think of using thermal imaging cameras to monitor the curing process of the several Carbon-fibre-reinforced polymer (CFRP) products that are integrated into the car.

FLIR T640 Camera

The FLIR T640 is a handheld thermal imaging camera that combines an ergonomic design, great flexibility and extremely high image quality.

With the crisp thermal image of 640 x 480 pixels the smallest of details can be seen. An intuitive user interface with touch screen make the FLIR T640 very easy to use.

"The important thing for us was obtaining good video images to be able to really monitor the component behaviour during a cycle in real-time," said Bauke Kooger. "We definitely like the resolution and image quality of the FLIR T640. And the camera is so easy to use, that you hardly need any training to get started."

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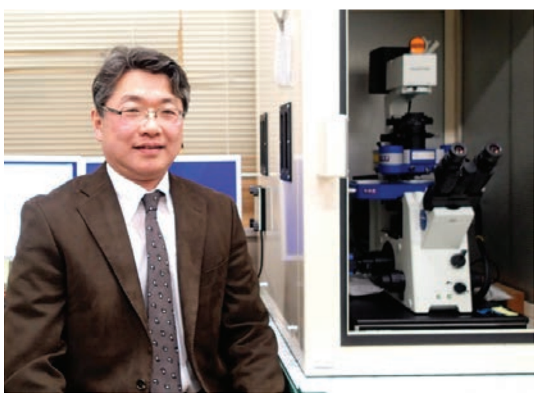
Quantitative Imaging Mode of the NanoWizard 3 used for Tissue Engineering Studies in Japan



JPK Instruments reports on the use of the Quantitative Imaging mode for tissue engineering studies at Niigata University.

Tomoyuki Kawase is an associate professor at the Institute of Medicine and Dentistry at Niigata University. His field of expertise is tissue engineering about which he has published several key papers. Professor Kawase is interested to determine the optimal stiffness or elasticity of cell scaffolding materials. In addition, it is also important to demonstrate dynamic changes in cytoskeletal fibre formation in response to the mechanical property of scaffolds.

Prior to learning about JPK's instrumentation, Professor Kawase used fluorescence microscopy and scanning electron microscopy. However, these instruments cannot determine the elasticity of materials and cells. Under the overall banner of atomic force microscopy, AFM, it is possible to study multiple properties of soft materials under aqueous conditions. Speaking about his choice of the NanoWizard®3 BioScience AFM system with the unique Quantitative Imaging, QI™, mode, Professor Kawase said his motivation was definitely the scanning speed. "For me, the QI mode seems technically easier than other modes especially in terms of softer materials such as living cells. I find that the JPK AFM is organised simply, and so is tough enough for a heavy user load. It is nd trouble-free and easy to maintain."

QI™ is the new quantitative imaging mode from JPK which was developed to make AFM imaging easier than ever before. With QI™, a force curve based imaging mode, the user has full control over the tip-sample interaction force at every pixel of the image. There is no longer a need for setpoint or gain adjustment while scanning. It is particularly powerful when imaging soft, sticky or loosely attached samples or samples with steep edges. QI™ comes as standard with the NanoWizard®3 family of AFMs.

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