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 Federal Ministry
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Digital and
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Forschungsgesellschaft

Faster testing means faster development

When electronic components are developed, their robustness must be tested. There are faster tests available – but are they reliable?

The topic

Electronic components are constructed of a variety of materials and layers that conduct electricity or insulate, are ductile or brittle and are made of metals, glasses and polymers. All of them are required for the function of devices but from materials science point of view they do not necessarily match together. They might not bind well to each other and they expand to different extents when heated. The different properties lead to high levels of thermomechanical stresses, in particular in switching operations. How long a component can withstand these stress is a critical characteristic of the final product. The ability to test this quickly and reliably would put companies a significant step ahead of the competition.

The research question

Electrical function is at the forefront in the development of new components, which are carefully assembled layer by layer. But how much stress can be applied before the layers no longer reliably bind to one another? And how does the component react to low-level but frequently repeated stresses? A reliable prediction of the robustness used to rely on complex electrical stress tests: over several months the power is turned on and off, thereby subjecting the component to tens of thousands of "on/off" or "hot/cold" cycles, simulating the operation of the final product. This naturally takes time – and is expensive. Infineon is

[CD Laboratory for Lifetime and Reliability of Interfaces in Complex Multi-Material Electronics](#)

Head

Dr Golta Khatibi; Vienna University of Technology

Operation

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Commercial partners

F&S Bondtec Semiconductor GmbH,
Infineon Technologies AG, Infineon Technologies Austria AG

Three questions to ...



Dipl.-Ing. Josef Fugger
Director R&D – KAI, Infineon Technologies
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How important is basic research for innovation?

That depends very much on the application area but basic research generally paves the way for innovation to arise. You have to think long-term: it sometimes takes years for the results of basic research to lead to actual applications.

What are the biggest challenges in collaborating with universities?

I see a large potential; Infineon is successfully working together with numerous universities throughout the world. The key thing is to define the mutual expectations in advance. It is important to have clear rules, for example relating to safeguarding intellectual property and to publishing results.

What do you like most about the CD Laboratory funding scheme?

The scheme enables companies to collaborate with universities on problems with a longer-term time horizon. The framework has enabled sustainable research groups to be established in the university environment. At the same time, the scheme has the flexibility to change its research programme during a CD Laboratory's operation.

thus looking for quicker and simpler tests to speed up the development of new and reliable products. A test of this kind would also open new markets for the producers of ultrasonic wire-bonding systems that can be developed into testing equipment. This explains why F&S Bondtec joined the collaboration – an ideal partner as it is the only producer worldwide with experience in both ultrasonic wire-bonding and bond testing.

Collaboration in the CD Laboratory

Ultrasonic methods are an established way for conventional fatigue testing of materials. They enable tens of thousands of stress cycles per second, so it would make sense to apply them to electronic components. Tests that previously took months could be carried out in a matter of hours. In Dr Khatibi, a materials scientist at the Vienna University of Technology, Infineon has found a partner with internationally recognized expertise. She is addressing the many questions raised by the method. For example, the ultrasonic test represents a vibration test at a fixed temperature: is the induced stress really the same as that caused by temperature cycles? And can the method be applied to miniaturized components and their layers? A transfer from the centimetre scale to the micro- and nanometre range is not self-evident as it must be scientifically validated and the method adapted. This requires detailed fundamental knowledge of the stresses in various types of component: high power semiconductors used in high-speed trains and wind power stations; smaller switches that permit high frequency power conversion in electronic equipment; and miniaturized intelligent power switches for complex automobile applications.

Results

The work in the CD Laboratory has already confirmed that stresses induced by ultrasonic vibrations can be equated to thermomechanical stress in certain areas. Based on this finding, F&S Bondtec has developed a prototype for quick tests of wire bonds in the high-performance applications (locomotives, wind power plants) and Infineon is already using it. There have also been promising preliminary studies of the transfer to smaller-scale applications at lower currents, smaller chips and thinner metal compounds (electronic equipment, automobile applications). The issue of whether the testing method is also appropriate for the cyclic testing of layered assemblies is still very much in the realm of fundamental research. Infineon expects the CD Laboratory to determine whether such a use will eventually become possible.

Scientific challenge

The development of new and appropriate test and measurement systems is a key aspect of material sciences. It requires a well founded knowledge of the test method as well as of the physical and chemical processes in the application. Ever more precise test equipment must be developed – and used to build models, simulations and methods, which in turn require experimental validation. Testing miniaturized components for evaluation of fatigue phenomena is not only relevant to electronics. The knowledge from the CD Laboratory can also be applied to medical technology, for example in the development of materials for stents, the implants that e.g. prevent the reclosure of blood vessels.

Added value for the company

F&S Bondtec has already developed a prototype based on the CD Laboratory's work and Infineon is using it to test the resilience of new power semi-conductors. Infineon's development of new technology is being substantially accelerated, enabling the company to maintain and increase its innovative advantage. Initial studies on the use of the method in other miniaturized applications are promising.