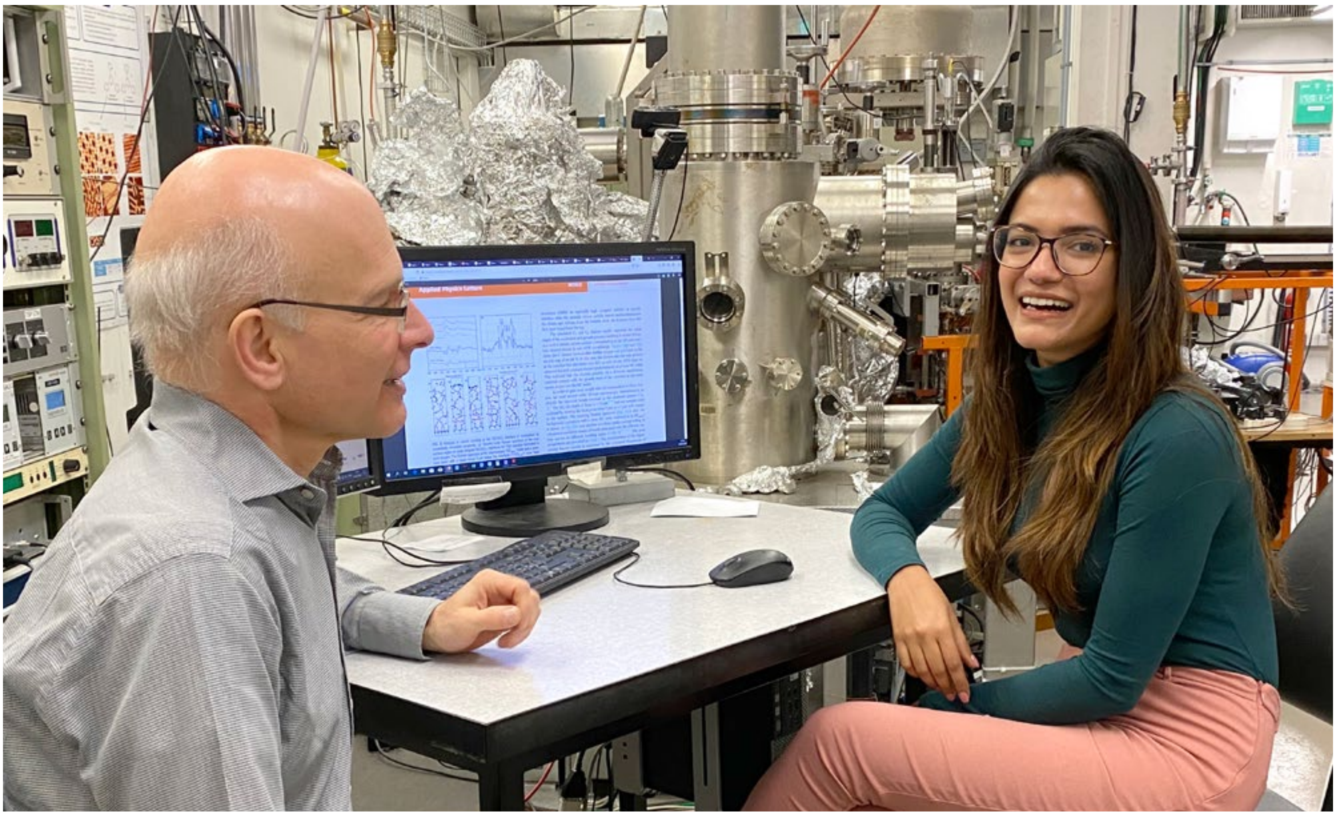
# The SNI supports PSI titular professors
## Thomas Jung investigates silicon carbide

Titular Professor Thomas Jung supervises a research group at the Department of Physics at the University of Basel and a team at the Paul Scherrer Institute. Both groups work with nanostructures – including molecules on surfaces and at interfaces – whose mechanical, magnetic and electronic properties are of interest to Thomas Jung. In 2019, for example, his team published a study in Applied Physics Letters that examines what exactly is preventing the use of silicon carbide in power electronics today.

**Necessary infrastructure**
Global energy consumption is rising steadily, as is the importance of electric power and sustainable sources of energy such as wind and solar power. However, electrical power is often generated a long distance away from the consumer. Efficient distribution, transport and control systems are therefore just as essential as transformer stations and power converters that turn the generated direct current into alternating current.

**Enormous savings are possible**
The power electronics used today must therefore be able to handle large currents and high voltages. Transistors made of semiconductor materials for field-effect transistors are now mainly based on silicon technology. But silicon carbide – a compound made up of silicon and carbon – would provide a number of decisive physical and chemical advantages over silicon alone. It has much higher heat resistance and delivers significantly better energy efficiency, which could lead to enormous savings.



Thomas Jung and Dipanwita Dutta can influence the occurrence of defects in the oxidation process of silicon carbide.

These advantages are known to be significantly compromised by defects at the interface between silicon carbide and the insulation material silicon dioxide. The defects are based on tiny, irregular clusters of carbon rings bound within the crystal lattice, as researchers led by Professor Thomas Jung were able to show experimentally. Using atomic force microscopy and Raman spectroscopy, they proved that the defects not only occur at the interface but are also found in some atomic layers of silicon carbide.

**Experiments confirmed**

The interfering carbon clusters, which are only a few nanometers in size, are formed during the oxidation of silicon carbide to silicon dioxide at high temperatures. "If we change certain parameters during oxidation, we can influence the occurrence of the defects," explains Dr. Dipanwita Dutta, who did her PhD in the Jung lab. For example, a nitrous oxide atmosphere during the heating process leads to significantly fewer carbon clusters. Post-treatment with nitrogen also has positive effects.

The experimental results were confirmed by the team led by Professor Stefan Gödecker from the Department of Physics at the University of Basel. Computer simulations showed exactly the same structural and chemical changes induced by graphitic carbon atoms as were observed experimentally. The positive effects of treating silicon carbide with nitrogen were also confirmed.

**Better use of electricity**

"Our work could advance the development of field-effect transistors based on silicon carbide and contribute to more effective use of electrical energy," says Thomas Jung, who initiated this project together with representatives of ABB as part of the Nano Argovia program.

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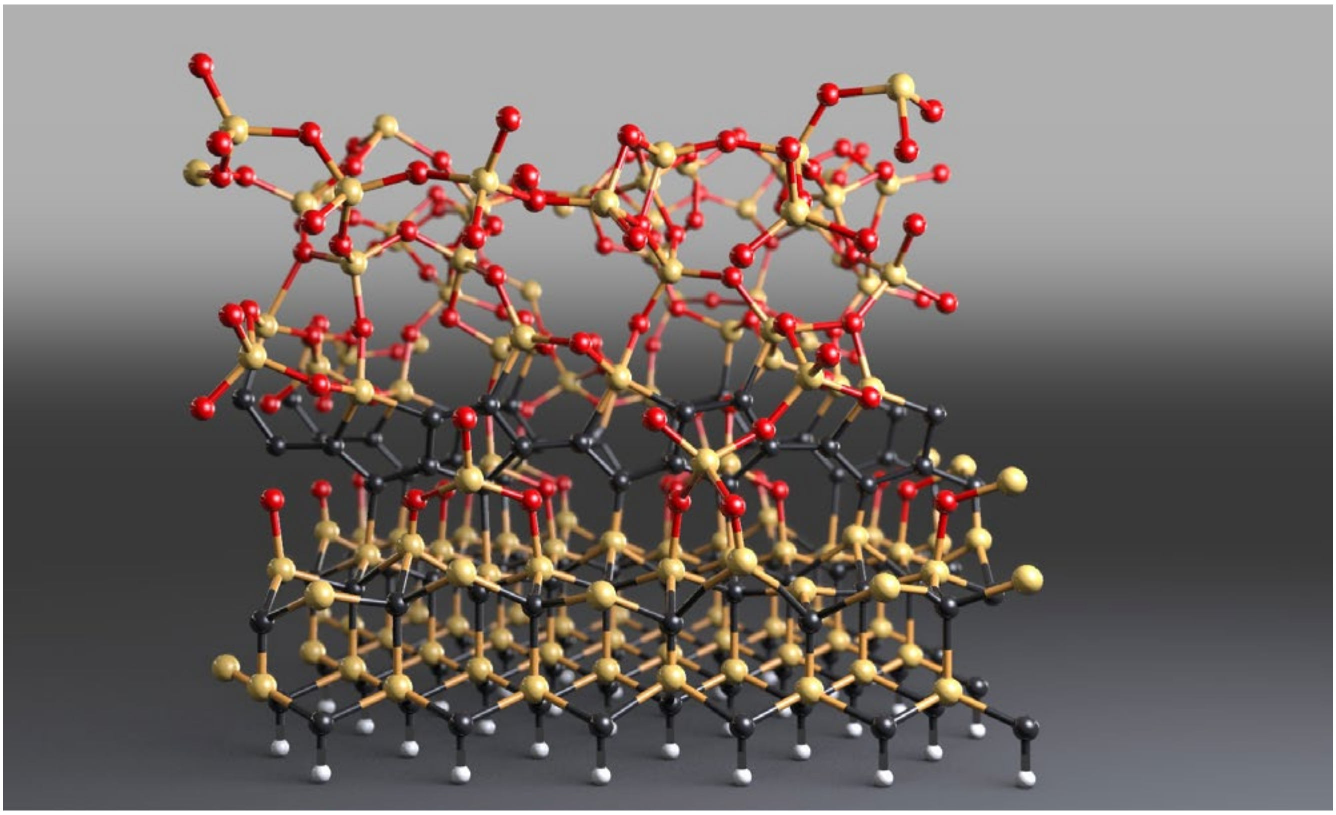
**Prof. Dr. Thomas Jung, Department of Physics, University of Basel and Paul Scherrer Institute**



The oxidation process of silicon carbide forms defects: At the interface between silicon carbide (periodic black-yellow atoms) and the insulating silicon dioxide (red-yellow atoms), irregular clusters of carbon rings (irregular black structures embedded in red and yellow atoms) occur. These are bound within the crystal lattice and disturb the current flow. (Image: Departement of Physics, University of Basel)