**Heat Protection for Turbine Blades**

*A gas turbine is an example of Siemens' engineering excellence. In order to construct turbines that operate with the highest efficiency, while still keeping the costs competitive, researchers and developers must consider the interactions of many factors. One important point is the coating of the turbine blades. When the turbine is operating, these blades are exposed to extremely high temperatures, enormous centrifugal forces due to rotation, and very great flow speeds. Turbine blades are cast from a metallic base material. In order for this material to remain undamaged if the combustion temperatures exceed the melting point of this material, the blades are protected with a ceramic coating. Inventor Dr. Stefan Lampenscherf has developed a number of measurement methods and models that enable engineers to make precise predictions about the durability of these thermally insulating coatings.*

Lampenscherf has been working for Siemens Corporate Technology (CT) in the field of materials technology at the Research & Technology Center in Munich since 2000. A physicist, he was already involved in materials science as a doctoral candidate at the Technische Universität Dresden. He gained additional experience in this field at the University of California in Santa Barbara as the recipient of a scholarship from the Alexander von Humboldt Foundation. For around ten years Lampenscherf's work at Siemens CT has, in addition to his work on other research topics, particularly focused on the question of how to predict the properties and lifespan of ceramic protective coatings. This information is needed for the design of individual components and for determining gas turbine maintenance intervals.

"We can't spend 10,000 or more hours testing a newly developed turbine blade coating in real time; that would be prohibitively expensive," explains Lampenscherf. Instead, working together with his colleagues, he has developed a number of methods that use laboratory tests as a basis for making predictions about how materials will behave under real operating conditions inside a turbine. These tests require special samples, which are prepared according to the CT researchers' specifications. Lampenscherf and his team examine the properties and stability of these samples, using specially developed mechanical and thermal test procedures. The measurements and information about material properties that are obtained in this way are used to simulate how the thermally insulating coatings will behave under real-world conditions in a gas turbine. By following these steps, the researchers gain knowledge about the operating conditions that would cause protective coatings to develop cracks and ultimately detach from the turbine blades. In a real-world situation this detachment is something that must be avoided at all costs; otherwise the turbine blades would be greatly damaged by the hot gas. This could lead to expensive repairs or even failure of the gas turbine. "Some cracking is unavoidable over the many thousands of operating hours that a turbine blade is in service," says Lampenscherf. "But we need to recognize and predict when such cracking will lead to dangerous detachment events that would destroy the protective coating."

To do this, countless different factors must be taken into consideration. The arrangement of the turbine alternates between stationary guide vanes and running blades, the blades vary in size, and each type of turbine has different operating characteristics in terms of temperature, flow characteristics, and pressure. Only after a turbine blade is optimally configured — in other words, when it has the right protective coating — will it be tested under real-world conditions. These trials are carried out at a testing facility in the gas turbine plant in Berlin. Here entire turbines can undergo tests lasting up to several hours. "There are always a few surprises during this testing," says Lampenscherf. "For example, the protective coating might wear away at a place where we didn't expect it." After all, a turbine blade has a complicated, dynamic interior and many different curved surfaces. "Layer by layer, we build a model of the entire blade and its coating in the computer," says Lampenscherf. At the moment there is no end in sight for this work, as requirements concerning the efficiency, performance, and flexibility of gas-fired power plants have recently been increasing dramatically.

A father of three, Lampenscherf spends his free time with his family. In the 13 years that he has worked for Siemens, Lampenscherf has registered 80 inventions, which are protected by 17 individual patents in 47 IPR families.