Taking a close look, whatever the scale

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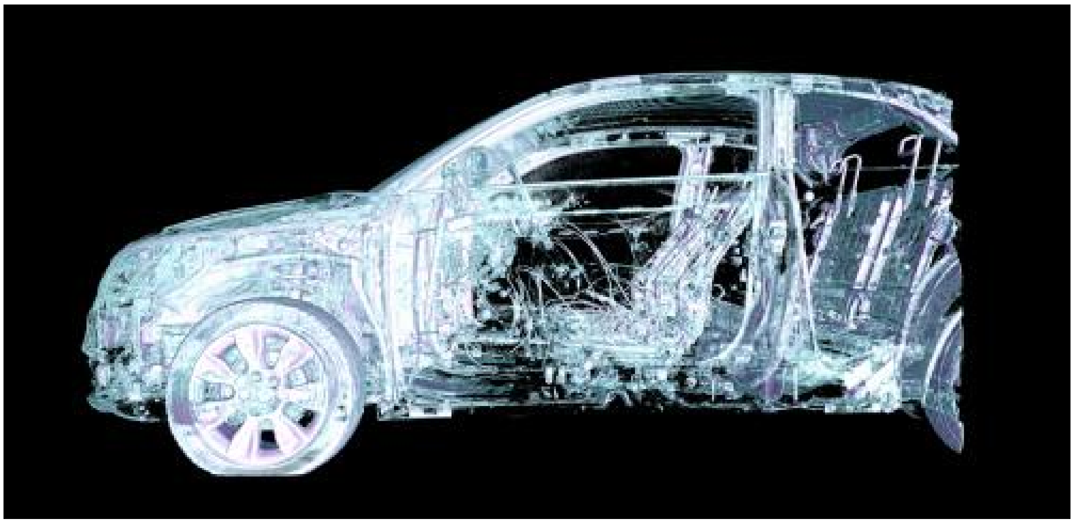

Through the eye of the XXL CT scanner: A car reveals its innermost secrets at the Fraunhofer Development Center for X-ray Technology EZRT in Fürth. Credit: © Fraunhofer IIS

Following the 50 km/h crash test, all that was left of the car was a heap of metal – one that contains valuable information on how vehicle safety could be improved. But the only way engineers can get at this information is if they can see inside the vehicle to analyze how its individual components reacted to the force of the impact. The typical two-dimensional X-ray images used in conventional materials testing are often not accurate enough, as what they show is no more than a kind of shadow-picture taken from a single angle. Computed tomography (CT) offers researchers many more possibilities for examining components: By recording parts in all three dimensions, it allows them to be measured and inspected in a contact-free and non-destructive way. But how do you fit an entire car into a CT scanner?

XXL CT scanner developed for shipping containers

Scientists at the Fraunhofer Institute for Integrated Circuits IIS have the answer. They have developed a huge CT scanner that will in future scan cars, airplane wings and even entire shipping containers. It works as follows: First, the object to be examined is hoisted onto a giant turntable. As it turns, an X-ray source on one side of the object moves up and down, and these movements are mirrored by a four-meter-long X-ray detector on the other. The readings are sent to a computer, which then generates a three-dimensional image. "We have never been able to carry out non-destructive materials testing on this scale before," says Professor Randolf Hanke, director of the Fraunhofer Development Center X-ray Technology EZRT. At the resolution the system currently achieves – which at 0.8 mm is already extremely high – scientists can make out even the tiniest of details with pin-sharp precision on objects that are several meters in size. Researchers hope soon to improve the resolution even further to 0.4 mm. Some of the potential uses for this technology include bringing prototypes of new cars into alignment with design data, or spotting material failures such as minuscule cracks in automotive or aircraft components. Security forces could use the giant scanner to detect explosives or other prohibited objects in shipping containers without having to open them.

CT machine heading for nanoscale scans

This giant piece of equipment has a counterpart that Prof. Hanke can comfortably carry around with him wherever he goes. No bigger than a microwave oven, and with a resolution of 0.02 mm, it can scan anything from the smallest plastic parts to biological samples. Now that they have developed what is currently the smallest portabel CT scanner in the world, Prof. Hanke and his team are already working on the next innovation: a device that will be able to push the limits of geometric magnification down to even higher resolutions. The aim is to be able to scan at nanoscale level, that is to say, at a magnitude of under 100 nanometers. This vision has been driving Prof. Hanke's research for the last 15 years. He and his team of students and postgraduates at the Chair of X-ray Microscopy at the University of Würzburg recently enjoyed a significant breakthrough. "We've now succeeded in customizing an electron microscope in such a way that it is able to produce a nano X-ray source," he explained. The clever part is that the electric charge carriers that generate the X-rays are conducted onto the side of a thin needle. The resulting X-rays emitted from the tip of this needle deliver a precise focal point 50 nm in diameter for scanning nanoscale objects in clearly defined detail. One thing this technology would allow biologists to do is to analyze the way water is transported within wood fibers.

In July of this year, the new EZRT building was officially opened in Fürth-Atzenhof, and Prof. Hanke is very pleased: "This new building, which will be home to our industrial computed tomography activities, allows us to pool our expertise to address problems at any scale in a wide range of fields. Our equipment and understanding of the process means we can scan everything from ancient works of art to entire wind turbines."

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