Hansen Family Award goes to Professor Stefan W. Hell

# **Live broadcast** from the cell

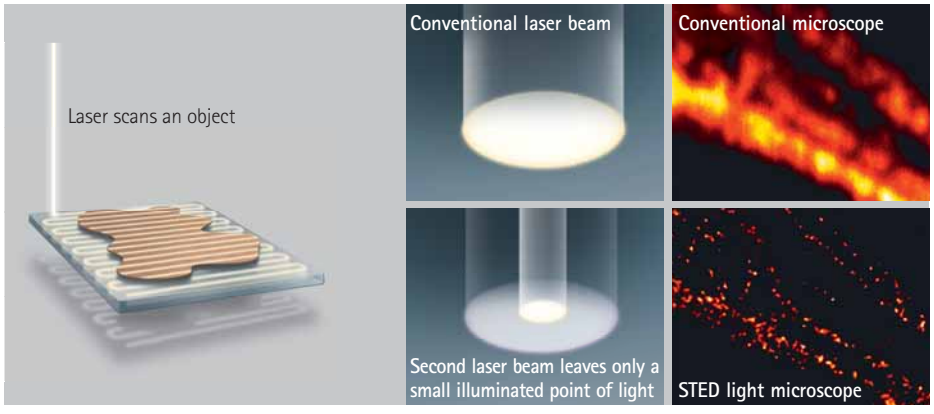
*Professor Stefan W. Hell has revolutionized the physics of light microscopy and refuted the law put forward by Ernst Abbe that had stood undisputed for more than 130 years. In recognition of these achievements, he was honored with the 2011 Hansen Family Award. Thanks to his invention, scientists can now observe the nanostructures in living cells in high resolution. The STED light microscope and associated methods make it possible to study the causes of diseases more closely and may thus potentially speed up development of drug products too.*



Medical science needs more light. After all, when an organ is diseased, it is helpful to know what processes are occurring differently in the diseased cells than in healthy ones. But the nanoworld of our body is complex and dark. If you look into a cell with a microscope under normal lighting conditions, you will see an undefined mass of some 40,000 different proteins, fat molecules and water. Even though the individual proteins are very different and each one performs an important function in the cell, they all look the same. Being able to clearly differentiate among the numerous molecules makes it easier for scientists to develop effective medications to treat cancer or cardiovascular diseases. This means they need high-resolution images from inside these building blocks of life. "No matter which disease you take – cancer, Parkinson's or Alzheimer's, even the flu or a similar illness – the cause is always to be found in the cells," explains Professor Stefan W. Hell, who conducts research at the Max Planck Institute for Biophysical Chemistry in Göttingen and the German Cancer Research Center in Heidelberg.

The scientist has received the 2011 Hansen Family Award from the Bayer Science & Education Foundation for his groundbreaking invention in the field of light microscopy. Thanks to Hell's discoveries, it is now possible to probe far deeper into the molecular scale of life. The scientist developed a new light microscope, one that has pushed back the borders of physics. "Light travels as a wave. If you try to focus it on one point, the wave bends and the point will have a light spot of half a wavelength," says Hell.

## How the STED light microscope works




*A laser beam causes fluorescent-labeled structures in a cell to illuminate. Until now, this produced only blurred images of the proteins (top right). In a STED light microscope, a second light ring – known as the STED beam – is superimposed on the first laser beam. This darkens many fluorescent beams. Only a small point of light in the center remains. The new STED microscope thus achieves very high resolution, and the cell structures appear much more sharply defined (bottom right).*

### Opening a window on the nanoworld of living cells

Until Hell's discovery, Abbe's theory was regarded as an unassailable law. According to this theory, points that are closer than 200 nanometers together – that is one five-thousandth of a millimeter – cannot be clearly distinguished from one another. They appear only as a blurry whole, even under the most powerful light microscopes. "That may sound small, but for the interior of the cell it is huge, ten to 100 times larger than most proteins," says Hell. Modern electron microscopes can be used to view structures down to 0.1 nanometers in size, but this is only good for allowing researchers to examine dead material.

Scientist with a clear focus: Professor Stefan W. Hell has pushed back the borders of physics with the development of his new light microscope. Thanks to his invention, cell biologists can now observe even the molecular details of living cells.

## Supporting innovative researchers

*The Hansen Family Award honors scientists who have performed pioneering research in innovative areas of biology and medicine. The prize is awarded by the Bayer Science & Education Foundation. The primary objectives of the foundation are the recognition of outstanding research achievements, the promotion of talented researchers and support for significant school projects of a scientific nature. The foundation honors outstanding research achievements every two years with the Hansen Family Award and in the off years with the Otto Bayer Award, each of which carries a purse of EUR 75,000. In 2008, the foundation established a third scientific prize – the Bayer Climate Award, endowed with EUR 50,000.*

Video on the web: more information on the Hansen Family Award and Professor Hell at bayer.de/r010

Hell's invention has thrown the window onto the nanoworld of biochemistry wide open. Using his Stimulated Emission Depletion (STED) microscope, scientists can now observe living cells. The sharpness of the images is no longer limited by the wavelength of light.

This is how the microscope works: first, the researchers insert fluorescent molecules into the cell and affix these markers to the proteins that they want to study. They then illuminate the sample with a beam of light. Initially this creates nothing more than a blurry spot of light. Then, however, the researchers make use of yet another physical phenomenon. A special light ring, known as the STED beam, is superimposed on the first spot of light. The majority of marker molecules in the round focal spot are darkened during this process. Only the protein markers in the small hole at the center of the light ring continue to fluoresce, i.e. send back colored light. This makes it possible to view the cellular structures in great clarity.

Hell can now make details of less than ten nanometers in size visible. In principle, it is even possible to view individual molecules in this way. "When we can observe the inner workings of the cell live, then we can see when what happens where – or even watch when things get out of control," says Hell, who has already been honored with numerous awards for his revolutionary discovery. In 2006 he was the winner of the German Future Prize, which is awarded by the German Federal President in recognition of outstanding contributions to innovation and technology, in 2008 he was the recipient of the Gottfried Wilhelm Leibniz Prize from the German Research Foundation and in September 2011 he received the Körber European Science Prize. "Being able to better watch how a medication works in the cell could dramatically reduce development times," he explains.

Hell has literally shed light on a whole new world, the interior of the cell. Scientists around the world now have reason to hope that we will ultimately acquire a much better understanding of what it means to be sick. Says Hell, "This will enable us to far more easily identify the Achilles' heel of a disease in order to combat it more effectively."

**www.research.bayer.com/hansen-family-award**
*Further information on the light microscope*

Photos: DZP (3), Bernd Schuller (1)/Max-Planck-Institut für Biophysikalische Chemie Göttingen