Press release

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Seeing viruses in a new light with nanoholes

Nanohole fibers made of quartz glass permit nondestructive detection of viruses – Collaborative development by Heraeus, Harvard University, Leiden University and the IPHT in Jena

Revolutionary development for virus research: Scientists at the Leibniz Institute of Photonic Technology (IPHT) in Jena, in cooperation with others at Heraeus Quarzglas, Harvard University (in the United States) and Leiden University (in the Netherlands), have succeeded in the marker-free and nondestructive detection of viruses with dimensions smaller than 20 nanometers (a nanometer is one millionth of a millimeter). They did so using an innovative nanohole fiber similar to an internet fiber and made of quartz glass from Heraeus. Fields of application range from medical diagnostics to the analysis of drinking water. This pioneering advance makes it possible to observe viruses in their natural environment, without manipulation. Initial measurements with test viruses have already been completed at Harvard and Leiden.

Viruses can be the cause of life-threatening infections such as flu or intestinal diseases. As viral diseases increase and spread, the clear detection and definite identification of adaptable pathogens is becoming increasingly important. The more scientists know about the structure of viruses and their rapid adaptation to the human immune system, the better the measures they can develop to combat them. The problem: Viruses are 300 to 400 times smaller than the diameter of a human hair, and therefore nearly invisible. Virological diagnostics offer a number of elaborate options. These include scanning electron or fluorescence microscopy, methods that require preliminary steps such as dyeing or spatial fixation. However, marking a virus with a dye changes its properties. The new nanohole method sidesteps these disadvantages, because the fiber can be integrated in standard microscopes, thereby expanding their detection limit to other nanoparticles.

Heraeus developed the nanohole fiber

Heraeus Quarzglas worked with an IPHT research team to develop the fiber. The unusual glass fiber was produced right at the Heraeus facilities in Hanau. Stefan Weidlich, physicist at Specialty Fiber Optics Research & Development at Heraeus Quarzglas, is pleased with the achievement: "Our application is distinguished by the fact that we put the viruses into quartz glass – one of the purest technical materials manufactured today. The fiber itself conducts light almost perfectly, without scattering it. But as soon as the light encounters the virus, some of it is diffracted. This allows very rapid observations with an extremely limited background. As a result, the movement of a virus can be observed and recorded within a period of several seconds.“

For production of the fibers, Heraeus covered the entire value chain. The process begins with manufacturing the preform from high-purity quartz glass and ends with drawing the extremely sensitive nanohole fibers. In selecting and characterizing the appropriate quartz glass material and developing the special, unusual design of the nanohole fiber, the technology group applied its combined expertise in the areas of telecommunications glass fibers and specialty fibers. As the world's largest integrated quartz glass manufacturer, Heraeus has been advancing innovations in quartz glass for more than 110 years.

Nanohole fiber makes new observation methods possible

The core of the fiber contains a nanohole with a diameter of 200 nanometers that extends along the entire fiber. Test viruses swimming in water are poured into this hole, and light is fed into the fiber core. The size and movement of the viruses can be determined by means of light scattering. The transmission of light in an optical fiber is based on a refractive index that decreases from the core to the cladding. If the light fed into the capillaries encounters a virus, part of the light is diverted from its direction of propagation; that is, it is scattered. When this scattering is observed through a microscope, the size of the virus can be determined.

For Heraeus developer Stefan Weidlich, the use of the nanohole fiber to examine viruses is just the first of many applications. "We envision other fields of application in medicine, in life sciences and in sensor technology. For example, it could be used to measure very valuable small particles in a liquid, such as pharmaceuticals, because the sample volumes required for the nanohole fibers are so minimal."

Note: The research results are summarized in a technical report at ACS Nano online: http://pubs.acs.org/doi/abs/10.1021/acsnano.5b05646

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