Lasers offer an automated way to test drinking water

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Little larger than a shoebox, the demonstrator was developed as part of the IRLSENS project. It is a quick and automated way to analyze water samples at the waterworks itself. Credit: © Martin Wagenhan / Fraunhofer IAF

To keep drinking water clean, experts are constantly monitoring our supply to check it for contaminants. Now laser technology will give them

a helping hand: a new system automatically analyzes water samples at the waterworks itself.

In today's world, we simply cannot do without lasers. We use them to print out documents, play CDs or DVDs, weld, cut, or bend car components, survey roads, monitor our bloodstream, and even remove tumors from our bodies. Now researchers from the Fraunhofer Institute for Applied Solid State Physics IAF in Freiburg have developed the technology for a further application. Their quantum cascade laser – a particular type of infrared laser – forms the core of an analysis apparatus that allows drinking water to be sampled automatically at the waterworks itself. As a result, water companies can determine within a few minutes whether their water contains any impurities – and what those impurities are. The system has been designed in order to enable immediate identification of dangerous substances. "The equipment samples the water for dangerous substances at the waterworks itself in the course of routine operations, and allows for a rapid response," says Dr. Frank Fuchs, summarizing the advantages of the system. Dr. Fuchs is Fraunhofer IAF coordinator for the IRLSENS project, which is funded by Germany's Federal Ministry of Education and Research (BMBF).

To examine the components of water, experts use molecular spectroscopy: that is to say, they examine the optical spectra of the molecules in the water. Each chemical com-pound has a unique spectrum, since individual molecules vibrate and absorb light at characteristic frequencies. Water itself is a very strong absorber of infrared light; since the light sources employed to date have delivered little power, until now examinations of this sort have been possible only in a laboratory setting. "The main sticking point is the intensity of the light. In order to be in a position to employ molecular spectroscopy at the waterworks itself, we needed to find a more powerful light source," explains Fuchs.

Taking water samples in the course of routine operations

Fraunhofer IAF's quantum cascade laser produces light that is up to 1000 times more concentrated than the silicon carbide thermal emitters used in the laboratory to date. Infrared radiation – which is at longer wavelengths that the human eye does not register – can be used to analyze impurities in the water. For molecular spectroscopy, analysts are interested in wavelengths between 7.3 and 11 micrometers. No longer must the water samples be prepared in the laboratory, costing time and money. Instead, they can be taken in situ in the course of routine operations. The measurement system is only a little larger than a shoebox, works automatically, and requires hardly any maintenance.

A demonstrator has already successfully undergone initial practical testing. At the Kleine Kinzig waterworks in the Black Forest, tests were conducted on various concentrations of sweetener as a simulant substance. Measurements were taken every three minutes over a period of six weeks, with the fully automated system collecting a total of 21,000 samples. The results were excellent: every sample was recorded in perfect detail, and there was not a single error. Even the concerns regarding the susceptibility of the laser spectrometer to vibrations were proved unfounded, since the machines and pumps in operation in the machine hall had no adverse impact on the test results. Providing there is sufficient demand, project partner Bruker Optik, the company that built the demonstrator, would like to develop the measurement system into a finished product.

The German drinking water system maintains extremely high quality standards. All German waterworks have their water samples checked regularly in laboratories such as the project partner Water Technology Center (TZW) in Karlsruhe. What's more, each individual waterworks

keeps a close eye on misting, pH value, and electric conductivity so that they can intervene immediately in the case of any anomaly. "If we see any such anomalies, this novel laser technology can quickly identify the dangerous substance on site and support water experts as they assess the situation," finishes Fuchs.

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