SHEDDING NEW LIGHT ON SARS-COV-2

A newly integrated division of medicine and photonics at Tokushima University is investigating WAYS TO INACTIVATE THE SARS-COV-2 VIRUS RESPONSIBLE for COVID-19.

Developing light-based technologies used for disinfection and high-throughput testing requires close collaboration between medical and photonics researchers, so Tokushima University has created a division bringing these disciplines together. Work from its Institute of Post-LED Photonics (pLED) is already bearing fruit.

A professor of immunology at Tokushima's medical school, Koji Yasutomo, heads the new division and has been leading the collaboration that hopes to support the global response to the COVID-19 pandemic.

INACTIVATING VIRUS PARTICLES WITH DEEP ULTRAVIOLET LIGHT

"We have been working on the inactivation of the SARS-CoV-2 virus using deep ultraviolet light," says photonics researcher, Takeo Minamikawa. "We know this is a promising technology for disinfecting surfaces and liquids, but for the technology to be commercially useful, we first need to quantify the light level needed to inactivate the virus effectively."

Ultraviolet (UV) light is just as harmful to viruses as it is to skin cells, rendering them inactive and unable to replicate. Due to its structure and size, DNA is specifically sensitive to light with a wavelength of 265 nanometres, right in the middle of the UV range. However, while it might seem straightforward to irradiate liquids containing viral particles with UV light, there are many unknowns about exactly how much light is needed.

WE'VE BEEN WORKING ON THE INACTIVATION OF SARS-COV-2 USING DEEP UV LIGHT

The effects of light absorption by liquid, the most practical and energy-efficient wavelength to use, and at what point the viruses can be considered inert all need to be considered. None of these factors had been systematically quantified until Minamikawa's team investigated.

The team developed a deep UV (DUV) irradiation apparatus to quantitatively analyse the inactivation of a SARS-CoV-2 virus strain provided by the Kanagawa Prefectural Institute of Public Health. In collaboration with virologist, Masako Nomaguchi, they investigated inactivation efficacy at three wavelengths — 265, 280, and 300 nanometres using commercially available DUV-LEDs, and quantified the absorption of DUV-LED light by the culture medium to determine the amount of light actually irradiated to the virus.

They found that to inactivate 99.9% of SARS-CoV-2, total doses of 1.8, 3.0, and 23 mJ/cm² were needed for 265, 280, and 300 nanometres, respectively.

"While 280 nanometres required almost twice as much irradiation energy as 265 nanometres to inactivate SARS-CoV-2, it was the most practical choice for inactivation in terms of energy efficiency, device availability and cost," said Minamikawa.

He notes, however, that DUV-LEDs are still under development, and their efficiency is improving. "Even in such a situation, our data can still be used as a common standard for SARS-CoV-2 inactivation useful for the development of DUV irradiation apparatuses and techniques."

The team is now developing DUV-LED light sources for a range of applications, including virus inactivation.

DOING THINGS DIFFERENTLY

The pLED was established at Tokushima University, on Shikoku, an island off central Japan, to drive innovation and applications of new light technologies at deep UV, infrared, and terahertz wavelengths — light sources that are emerging as particularly promising in medicine, materials science and engineering.

"There are other groups in Japan combining photonics and medicine, but most are using visible light," explains Takeshi Yasui, the pLED institute director. "The originality of our collaboration is in using deep ultraviolet, terahertz, and infrared technologies, which are much less mature, so we need to make our own light sources and detectors. There are few research groups working in this area around the world."

Based on a suite of newly developed technologies at pLED, such as surface plasmon resonance (SPR) or optical frequency combs, Yasui's team is developing an optical biosensing method that could ultimately be used to quickly test for specific viruses, such as SARS-CoV-2 and other antigens in bioliquid samples.

"We are developing several types of SPR-based systems using different laser wavelengths and/or different optical configurations," says Yasui. "Combining nano-plasmonic structures with SPR, for example, enhances sensitivity, while near-infrared light has better sensitivity for this purpose than visible light. Our ultimate goal is to develop a hand-held photonics-based device that could be used at point of care for rapid, sensitive and specific antigen detection."

"Sometimes it is very difficult to detect small amounts of biomolecules, especially in serum, so high-sensitivity techniques like photonics might make such detections possible," says Yasutomo. "We have many medical researchers in Tokushima University who are looking forward to a long and rewarding collaboration with photonics researchers." ■

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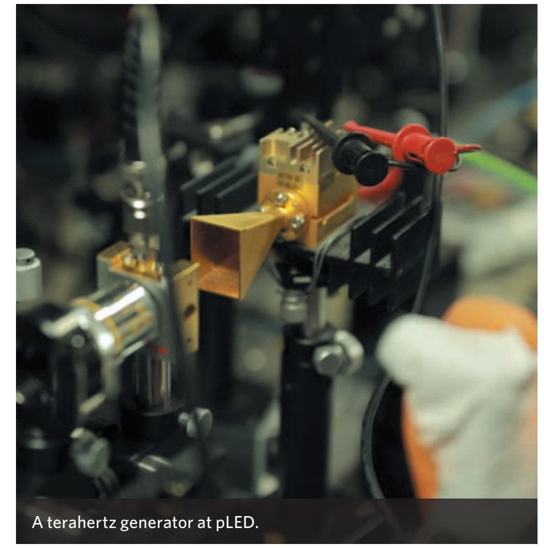
Photonic and medical scientists conducting collaborative research at pLED.


A terahertz generator at pLED.


A photonics scientist observing collagen using a second harmonic generation microscope at pLED.

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