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Singapore: NTU's Eco-Friendly Chip Extends Food Freshness

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Unlike traditional UV lamps that rely on mercury, the newly developed chip is mercury-free, eco-friendly and only a few centimetres in size. It can operate at full intensity within small, confined spaces without requiring a cooling system, making it highly versatile and ideal for areas where conventional UV lamps cannot be installed. Its small size and low energy consumption make it ideal for integration into a wide variety of everyday products, offering convenience without compromising safety.

Harnessing the power of short-wave UV (UVC) light, the chip efficiently eliminates bacteria, fungi and viruses by damaging their DNA. While mercury-based UVC lamps are commonly used for disinfection, their toxicity has prompted a shift towards safer, sustainable technologies.

The chip generates UVC light through cathodoluminescence, where a cathode made of ZnO nanostructures and an anode coated with a UV-emitting material interact under a voltage in a vacuum to produce powerful disinfection capabilities.

Designed to target a wide range of microorganisms, the chip predominantly emits UVC light at around 265 nm, while also delivering UVB and UVA light. This combination disrupts not just DNA, but also penetrates biofilms and damages critical cellular components such as proteins and lipids.

Operating effectively between -20°C and 100°C, the chip can be activated instantly, making it suitable for applications that require rapid disinfection. Its robust design ensures consistent performance even in extreme environmental conditions, enhancing its reliability for both consumer and industrial use.

Laboratory tests demonstrated the chip's impressive capabilities, rapidly reducing levels of pathogens such as *Pseudomonas aeruginosa*, *Escherichia coli*, *Legionella pneumophila* and even SARS-CoV-2, the virus responsible for COVID-19.

"The disinfection efficiency of our chip is comparable to conventional mercury lamps. We are excited about its potential applications in consumer products like food containers, refrigerators and medical devices," said Professor Hilmi Volkan Demir, Director of NTU's LUMINOUS! Center of Excellence for Semiconductor Lighting and Displays and lead researcher of the study.

The chip has already been incorporated into EcoLoc, a handheld device designed to work with specially developed food container lids that fit the IKEA 365+ series. The system uses UV treatment to eliminate pathogens on the food's surface, slowing spoilage and enhancing food safety. With daily use, the shelf-life of perishable foods like bread, fruits, vegetables and meats can be extended by up to a week with minimal impact on taste and odour.

"Our chip is a significant breakthrough in health and safety, with the potential to not only reduce food spoilage but also curb the spread of infectious diseases such as COVID-19," said Dr Vijay Kumar Sharma, senior research fellow at NTU's School of Electrical and Electronic Engineering and LUMINOUS! and first author of the study.

EcoLoc's effectiveness was further demonstrated with raspberries stored at 4°C; those treated with EcoLoc for three minutes daily remained in good condition even after seven days.

"This innovation also supports a greener future by reducing food waste," added Dr Sharma.

The CEO of the Swedish firm highlighted the chip's versatility: "The broad-spectrum UV technology we developed with NTU effectively combats biofilm formation and operates efficiently in small spaces without cooling, complementing existing UV technologies in the market."

Future iterations of the chip could be even smaller and more powerful, opening new possibilities across diverse sectors.

Looking ahead, the researchers plan to adapt the technology for broader applications, including medical equipment sterilisation, home sanitation and packaging solutions, further expanding its impact across various industries.

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