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NEWS RELEASE

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FOR IMMEDIATE RELEASE

Kobe University-Ushio Inc. Joint Study Shows Repetitive Irradiation with 222nm UV-C Does Not Cause Skin Cancer

Cypress, California (April 2020) — Ushio Inc. (TYO: 6925; headquarters in Tokyo, Japan) and a research group from the Division of Dermatology, Department of Internal Medicine, Graduate School of Medicine, Kobe University (Professor Chikako Nishigori, lecturer Makoto Kunisada, graduate school student Nozomi Yamano, *et al*.), demonstrated for the first time in the world via animal experimentation that repeated irradiation of 222nm ultraviolet radiation (UV-C) with high disinfection power does not cause skin cancer, suggesting its safety on human skin and eyes. This technology is expected to be utilized in a wide range of antibacterial and viral inactivation applications in the medical field and daily life.

The results of this research were published online in *Photochemistry & Photobiology* on March 29, 2020, and will be presented by Professor Nishigori on June 28 during the 2020 American Society of Photobiology Biennial Meeting in Chicago.

This research study was conducted with the support of the Grants-in-Aid for Scientific Research provided by the Ministry of Education, Culture, Sports, Science and Technology (JP16k10126).

Highlights

- The research study demonstrated for the first time in the world that repeated irradiation of 222nm ultraviolet radiation (UV-C) does not cause skin cancer when it was applied to mice with extra susceptible skin.

- The results of the research suggest that repeated irradiation of 222nm UV-C is also safe on human skin and eyes.

- The 222nm UV-C lamp unit used in the research included an optical filter to remove nearly all but the dominant 222nm wavelength. Irradiation with this lamp unit caused no onset of skin cancer or cataracts[*1] to the mice used in the research that are very susceptible to UV.

- These results suggest direct irradiation of 222nm germicidal lamps on humans is safe, enabling a wide range of antibacterial and viral inactivation applications is expected in the medical field and daily life.

Background of Research

UV-C (wavelength of 280-200nm) is absorbed in the ozone layer and does not reach the Earth's surface. To exploit its strong germicidal power, germicidal lamps emitting 254nm UV-C have been developed and used for anti-microbial applications. But these lamps have only been used in locations where people are not present because they have harmful side effects on the human body and may cause skin cancer and cataracts.

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The wavelength of the lamp used in this study was 222nm, which is shorter than 254nm. Its development started in the hope that it can be used in the medical field. According to the Division of Orthopedic Surgery at Kobe University (Professor Ryosuke Kuroda), 222nm UV-C is comparable to 254nm UV-C in terms of the ability to sterilize human skin. But its application in a medical facility has required proof that repeated exposure to 222nm UV-C is non-carcinogenic and safe because of the possibility that it could be directly and repeatedly irradiated on humans.

Research Methodology

To investigate the safety of repeated exposure of eyes and skin to 222nm UV-C germicidal lamps, the researchers repeatedly irradiated a 222nm germicidal lamp onto xeroderma pigmentosum group A[*2] model mice. This type of mouse is known to have an approximately 10,000-fold increased risk of developing skin cancer compared to wild-type mice. The 222nm lamp unit used in the study included a krypton-chloride (Kr-Cl) excimer lamp and an optical bandpass filter to remove nearly all but the dominant 222nm wavelength.

All mice in the control group onto which UV-B (wavelength of 280-315nm) was irradiated developed skin cancer, and many mice displayed adverse effects of corneal injuries and cataracts. UV-B is the wavelength range of the sunlight that causes skin cancer.

On the other hand, no mice in the 222nm germicidal lamp group developed skin cancer, nor were any abnormalities found at the microscopic level upon an analysis conducted with the support of the Division of Ophthalmology at Shimane University (Professor Masaki Tanito) (Fig. 1).

In addition, it became clear that the reason 222nm irradiation caused no harm was related to the level of skin penetration. The conventional UV radiation reaches the basal layer at the bottom of the skin's epidermis and damages the cells' DNA, whereas 222nm UV-C only reaches the keratinocyte layer at the uppermost superficial layer (the layer that becomes scurf) and causes no damage to the DNA of epidermic cells.

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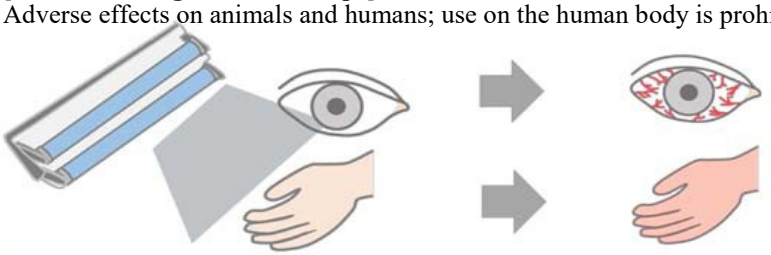
Development of Germicidal Lamps Safe for Human Application

[Conventional germicidal lamps]
Adverse effects on animals and humans; use on the human body is prohibited.

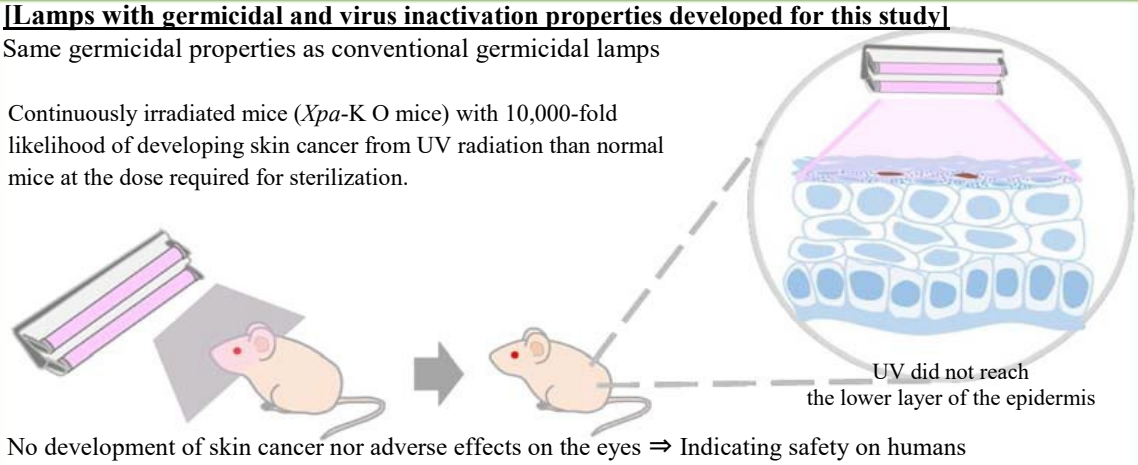


Corneitis

- Causes inflammation
- Possible skin cancer

[Lamps with germicidal and virus inactivation properties developed for this study]
Same germicidal properties as conventional germicidal lamps

Continuously irradiated mice (*Xpa*-K O mice) with 10,000-fold likelihood of developing skin cancer from UV radiation than normal mice at the dose required for sterilization.



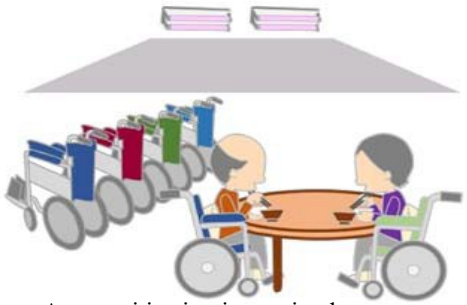
UV did not reach the lower layer of the epidermis

No development of skin cancer nor adverse effects on the eyes ⇒ Indicating safety on humans

[Future Applications]
Wide range of possible applications from medical areas to daily life

Hand sanitization

Restroom stall sanitization



Area sanitization in nursing homes, etc.

Figure 1

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Future developments

The results of this study indicate that although 222nm UV-C has a powerful germicidal ability, it can be directly irradiated on human skin. A wide range of antibacterial and viral inactivation applications may be expected in the future, such as hand sanitization in medical facilities and uses in locations where people enter, such as schools, nursing homes, food factories, toilets, and kitchens.

Glossary

*1 Cataracts - The crystalline lenses that work as lenses in the eyes are mainly made from protein and water. Proteins change and become white and cloudy under a variety of influences, including aging and years of UV exposure. As a result, the entire lens becomes cloudy, causing impaired vision.

*2 Xeroderma pigmentosum - A genetic disorder in which DNA damage caused by UV radiation cannot be repaired. People with this disorder can develop numerous incidents of skin cancer from elementary school age and upwards unless they are protected from UV. In Japan, it affects approximately 5 out of 100,000 people.

Research paper information

・Title: “Long-term effects of 222 nm ultraviolet radiation C sterilizing lamps on mice susceptible to ultraviolet radiation”
DOI: 10.1111/php.13269

・Authors: Nozomi Yamano, Makoto Kunisada, Sachiko Kaidzu, Kazunobu Sugihara, Aiko Nishiaki-Sawada, Hiroyuki Ohashi, Ai Yoshioka, Tatsushi Igarashi, Akihiro Ohira, Masaki Tanito, and Chikako Nishigori

・Journal carrying this article: *Photochemistry & Photobiology*

About Ushio America, Inc.

Ushio America, Inc. is a vertically integrated solutions company for lighting systems and components utilizing xenon short arc, lasers, ultra-high-pressure UV, excimer, metal halide, LEDs (specialty sensing and architectural lighting), halogen, fluorescent, and miniature incandescent lamps serving semiconductor, printed circuit, video projection, cinema, medical, life sciences, UV curing, germicidal, horticulture, landscaping, graphic arts, flashlight, scientific, medical, infra-red heating, lamp and laser drivers, systems and services, and numerous other applications. Established in 1967 as a subsidiary of Ushio Inc., in Tokyo, Japan, Ushio America offers a full spectrum of over 2,500 products and services to its customers. http://www.ushio.com

About Ushio Inc. (Headquarters: Tokyo, TSE: 6925)

Established in 1964, Ushio Inc. manufactures and markets a variety of light sources such as lamps, lasers, and LEDs ranging from UV to the visible and infrared region, as well as optical equipment and cinema related products incorporating these light sources. Many of its products enjoy high market shares in the electronics fields such as semiconductors, flat panel displays, and electronic component manufacturing, along with the visual imaging field such as digital projectors and lighting. In recent years, Ushio Inc. has expanded business to the life sciences such as medical and environmental fields.
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