

Killing Coronavirus with Ultraviolet Light

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Abstract

In the electromagnetic radiation spectrum, ultraviolet (UV) radiations cover the wavelength range of 100–400 nm, which is a higher frequency (ν) and lower wavelength (λ) than visible light. Disinfection by using UV light is nothing new as it's been a useful technology for over 40 years, contributing to clean water and clean air and there are many consumer devices using UV light to disinfect things. In the recent times of COVID-19 pandemic, UV radiations/light has attracted great significance to kill coronavirus or disinfect medical & electronic equipment, buildings by using high UV doses and using low doses for humans. This article gives a brief summary on the utility, devices and safety with UV radiations to deal with coronavirus

Keywords: Electromagnetic spectrum, UV radiations, Coronavirus, Disinfection.

Introduction

Ultraviolet (UV) radiations make a part of the solar radiations' spectrum, and Sun is a major natural source of these radiations.^[1,2] Naturally designed and developed Ozone layer in the stratospheric region of the Earth's atmosphere acts as a shield by absorbing most of the UV radiations to protect not only human beings but all sensitive biotic system of earth due to deadly effect of UV radiations.^[3,4] In the electromagnetic radiation spectrum, ultraviolet (UV) radiations cover the wavelength range of 100–400 nm, which has higher frequency (ν) and lower wavelength (λ) than visible light. Sun is the natural source of UV radiations, but it can also be created by artificial sources to be used in industry, commerce and recreation.^[5-7] The UV region covers the wavelength range 100-400 nm and is divided into three bands: UV-A (315-400 nm); UV-B (280-315 nm) and UV-C (100-280 nm). With the passage of sunlight through the atmosphere, all UV-C and approximately 90% of UV-B

radiation which correspond to higher frequency and more energy ($E=h\nu$, h is Planck's constant) is absorbed by ozone, water vapour, oxygen and carbon dioxide. UV-A radiation is less affected by the atmosphere and finally, the ultraviolet radiation reaching Earth's surface is mainly composed of UV-A radiations (with lower energy) with a very small component of UV-B. The amount of UV-A radiations reaching the Earth's surface from Sun depends on several factors like Sun's distance from Earth in the sky, latitude, cloud cover, altitude, the thickness of the ozone layer and also their ground reflection. Ozone layer and ground reflection components of UV radiations have been a point of discussion for human well-being due to decreasing ozone concentration in the Earth's stratospheric region as well as increase of greenhouse gases in the Earth's atmosphere due to growing unfriendly environmental activities of human beings. Reductions in the ozone layer due to human-created pollution may increase the

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amount of UV-B and UV-C that reaches the surface. The reaching of more energetic ultraviolet radiations from the sun due to environmental degradation can impact human health, animals, marine organisms and plant life. It has been found that in humans, increased UV exposure can cause skin cancers, cataracts and immune system damage.

Role in Disinfection

Disinfection, by way of UV light is nothing new as it has been a useful technology for over 40 years, contributing to clean water and clean air. There are many consumer devices using UV light to disinfect things, such as self-cleaning UV light water bottles and UV-emitting cases that clean dirty phones. In the recent times of coronavirus pandemic (COVID-19) UV radiations/light due to its energy being used has attracted great significance to kill or disinfect medical and electronic equipment from coronavirus. UV light has been shown to destroy other coronaviruses (SARS-CoV, MERS-CoV) and is effective on the novel coronavirus (SARS-COV-2) as well. Scientists and engineers are coming with different ideas and devices with the use of UV radiations as disinfectant.^[8-12] They are also studying the use of UV radiation to detect the virus in schools, restaurants and other public places. UV-C light has the most energy out of the three types and this energy destroys the genetic material inside viruses and other microbes. It works because UV-C light is strong enough to destroy the genetic material –either DNA or RNA-- of viruses and bacteria and stops them from infecting and/or replicating within a human cell. However, UV light damages the human skin, so it should only be used on objects or surfaces. Therefore, the health experts and the UV technology industry are working to define standards for UV disinfection technologies in healthcare settings. In future, ultraviolet (UV-C) lights would be able to disinfect contaminated public spaces to stop the transmission of the virus.

Consumer devices

Ultraviolet radiations/light has already been tested as the primary germ-killer in the natural environment and it makes sense to take this advantage towards coronavirus killing. The practice called 'Ultraviolet Germicidal Irradiation' has long been used in hospitals where pathogens abound. Therefore, widespread adoption of efficient UV approach is much in demand during the current pandemic, but it requires UV radiation sources that emit sufficiently high doses of UV light. The UV radiation with high dose generating device that currently exists, is typically an expen-

sive mercury-containing gas discharge lamp, which requires high power, has a relatively short lifetime, and is bulky. There is a need to develop high-performance UV light emitting diodes (LEDs) which would be far more portable, long-lasting, energy efficient and environmentally benign. While these LEDs exist, applying a current to them for light emission is complicated by the fact that the electrode material has to be transparent to UV light. A high-performance UV LED emitting a high intensity of UV light is needed to have a sufficient UV light dose to kill all the viruses and this is currently limited by the transparent electrode material being used.

While finding transparent electrode materials operating in the visible spectrum for display in smartphones and LED lighting is a long-standing problem, the challenge is even more difficult for ultraviolet light. A personal, handheld device emitting high-intensity ultraviolet light to disinfect areas by killing the novel coronavirus is now feasible. Portable consumer devices for their use for coronavirus disinfection aren't the only to find the use of UV light sanitization but some businesses are installing UV light fixtures in their facilities with an attempt to completely disinfect the buildings and mitigate the risk of contracting corona infection through air or surfaces. Though, the effectiveness of UV sterilization on surfaces such as floors and walls has been confirmed, further research is needed about the safety of indoor UV light fixtures as well as its worth at sterilizing clothes and human skin.

UV-C lamps and robots are commonly used to sanitize water, objects such as laboratory equipment, and spaces such as buses and airplanes.

In this pandemic everyone is skeptical about the purchases including groceries, that they bring home and want to disinfect the same. To solve this concern a company has developed a new product called 'Corona Oven' that uses UV light to kill coronavirus in a box-shaped disinfection chamber that uses UV-C rays to kill coronavirus in ten minutes. Once an object is placed inside the box, the device kills all types of viruses/pathogens from all sides, ensuring that each side and surface gets the UV-C radiation. It can be used for personal use and also by firms to disinfect surfaces of various objects, household grocery and food items, delivery parcels, masks, hospital PPE & tools etc. The Bangalore-based firm has developed this technology in partnership with Indian Institute of Science (IISc), Bangalore and the product has been scientifically verified in terms of UV intensity.

Precautions and safety

According to the guidelines on the diagnosis and treatment of the coronavirus released by the WHO & NHC (China), the virus is said to be sensitive to ultraviolet (UV) light and heat, so it is advocated that ultraviolet radiation can effectively eliminate/control the spread of virus. Though scientists are working on ways to make these powerful disinfecting products safe for people to use, current devices are not safe to use on human body. Scientists are exploring ways to use a specific type of UV-C light for devices that could be safe for humans including decontamination of disposable masks, in order to make them reusable just in case short supply is expected, particularly in the healthcare facilities. Till now, it is not safe to use UV sanitizers on the body because exposure to UV-C light is dangerous for humans. UV-C sanitizers can damage eyes and skin, and can also cause cancer. UV-C wands, pouches, and lamps are also sold for home use—for example, disinfecting cell phones. However, the safety and effectiveness of these products is not known. Beware of false claims that say these products are effective or are for use on humans. However, till date the existing UV based products in the market are not proved to be safe to use on human body. As per the guidelines for the use of UV disinfection, indoor spaces should be disinfected with ultraviolet light with an intensity of over 1.5 watts per cubic meter. A UV lamp can disinfect objects within one meter for an exposure of at least half an hour and longer exposure is needed when the indoor temperature is below 20°C or above 40°C and relative humidity is over 60 percent. As a precautionary measure, a room should be ventilated after UV disinfection, and people are suggested to enter the room half an hour later.

Future

The amount of ultraviolet radiation required for disinfection of an object varies widely depending on factors such as the shape and type of material with the virus. Nevertheless, a concentrated form of UV-C radiation dose is on the frontline to fight against COVID-19. Whole buses are being lit up by the ghostly blue light each night, while squat, UV-C-emitting robots have been cleaning floors in hospitals and banks have even been using the light to disinfect money.

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