Emerging disinfection technologies for manufacturers and consumers

Research Support Service

April 2020

Prepared by: **PreScouter**
Daniel Morales, PhD | Technical Director
Paromita Raha, PhD | Researcher

PRESCOUTER

Intelligence Brief Question

What new technologies are enabling safe, rapid and efficient disinfection for both manufacturers and consumers?

In light of the current COVID-19 pandemic, we are seeing an upsurge in novel technologies and measures undertaken by the manufacturers of consumer packaged goods (CPG) to maintain safe hygiene and disinfection practices while manufacturing, packaging and delivering goods. On the consumer end, it is equally important to follow stringent measures to minimize the risk of spreading viral contamination while handling food and goods both while procuring essential products at stores or while receiving packages at home. The SARS-CoV-2 is known to have varying aerosol and surface stability depending on the surface composition. Hence, in addition to following best hygiene practices, such as washing hands and sanitizing high touch surfaces often, novel disinfection methods can play a vital role in preventing the spread of viruses.

In this report, we present examples of emerging technologies that can be adopted by CPG manufacturers and consumers to prevent the spread of viral contamination.

Executive Summary

The SARS-CoV-2 virus

What is the SARS-CoV-2 Virus?

SARS-CoV-2 is a positive-sense single-stranded RNA virus from the severe acute respiratory syndrome–related coronavirus species.

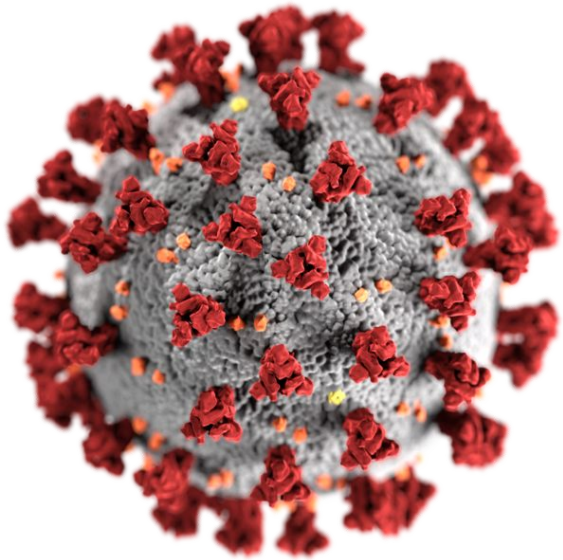
It emerged in China in December 2019, in a wet market of Wuhan.

Early studies demonstrated that SARS-CoV-2 binds a **membrane receptor** called human angiotensin converting enzyme 2 (hACE2).

hACE2 is expressed in different organs, such as the **lung, heart, kidney, and gastrointestinal tract.**

Once the virus binds and enters the host cell through the receptor, it **bypasses the host cell mechanisms and replicates**.

Cellular damage results either from the **virus that controls the host cell's mechanisms** or the **immune cells that kill the infected host cells, resulting in massive cell death**.



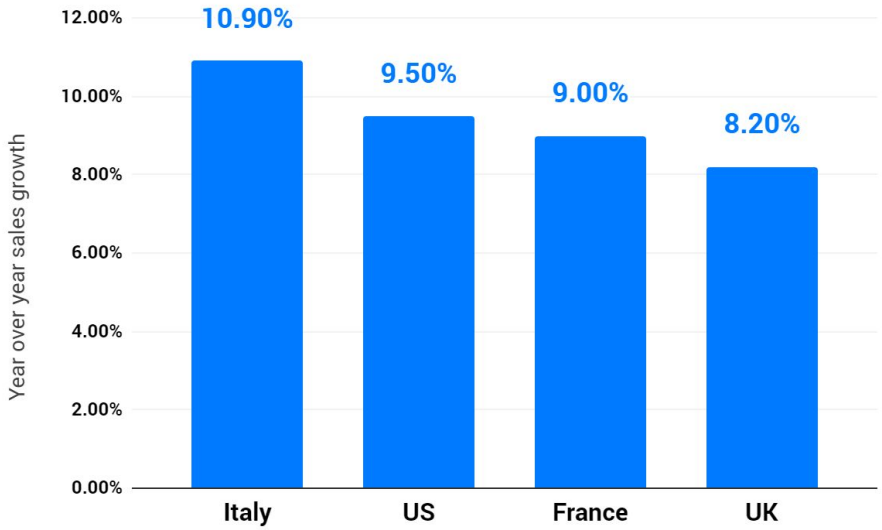
Executive Summary

Increased demand for CPG goods

The impact of COVID-19 on CPG industries around the world has been a shift in the supply and demand equation. Growing demands for food, beverage and home improvement products have heightened stringent disinfecting and cleaning procedures in the manufacturing facilities. There has been a remarkable increase in sales of hand sanitizers, medical masks, thermometers and aerosol disinfectants due to the pandemic.

Thus, disinfecting all surfaces in manufacturing facilities including machine control panels, packaging centers, shipping/receiving areas, air conditioner parts, shared electronic devices and office supplies is critical.

The US Environmental Protection Agency (EPA) has published a list of disinfectants and antimicrobials for use against coronavirus, which can be consulted by both manufacturers and consumers.



Change in consumer packaged goods sales due to the coronavirus pandemic worldwide in March 2020.
Source: Statista.

Executive Summary

Overview of SARS-CoV-2 viability on surfaces

Current evidence reveals that COVID-19 is transmitted between people through **respiratory droplets** from an infected person and through **fomites** which are infected surfaces in the vicinity of the infected person. People can get infected with the virus by touching infected surfaces and then touching their mouth, nose, and eyes. The risk of infection from various surfaces differs, as shown in a recent study in the New England Journal of Medicine that found the virus to be viable on copper for 4 hours, cardboard for 24 hours, stainless steel for 48 hours and plastic for up to 72 hours. We thus need to be cautious when touching fresh produce and consumer packaged goods either at the store or when receiving packages delivered at home.

4 HOURS

24 HOURS

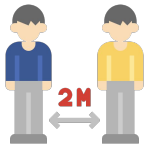
48 HOURS

72 HOURS

Executive Summary

Guidelines for Food and CPG manufacturers

The Consumer Brands Association (CBA) and Food and Beverage Issue Alliance (FIBA) have jointly developed the following resources for response during the COVID-19 pandemic:



Emergency prevention measures for physical distancing in food manufacturing facilities.

Food Industry recommended protocols when employee/customer tests positive for COVID-19.

Screening food industry employees for COVID-19 symptoms or exposure.

Proper usage of face masks

CPG companies are also implementing new policies and incentives like bonuses, raises, more leaves and increased hiring to ensure their employees are valued as they make sure our supplies are not limited while increasing the overall sanitation and hygiene practices on manufacturing floors.

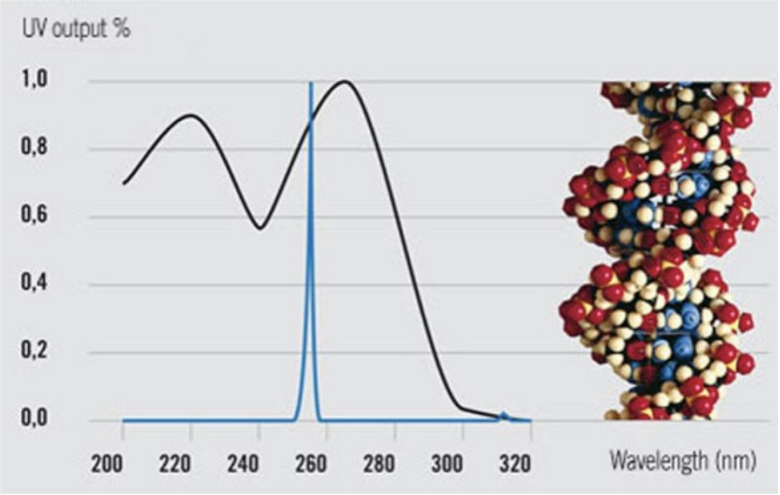
Executive Summary

Best disinfection practices for manufacturers

In the CPG industry, apart from the quality of the product, high hygiene requirements should be met in the filling and packaging process. In particular, microbiologically sensitive bulk products such as food require packaging materials with low germ counts.

Compared to chemical and thermal methods, UV light radiation treatment is a simple, fast, cost-effective and reliable method for disinfection in food and consumer goods packaging plants. UV radiation of wavelength between 200 to 300 nm destroys living cells by causing irreversible DNA damage and is thus effective against microbes as seen in the adjacent graph.

Even in the pharmaceutical and cosmetics industry, the method of surface disinfection with UV light is extensively used to inactivate bacteria and viruses.



Blue: The spectrum of a UV lamp. Black: The spectrum of microorganism inactivation. Source: Heraeus Noblelight GmbH

Executive Summary

Best disinfection practices for consumers

CDC recommends the following measures to prevent the spread of COVID-19:

- **Clean** frequently touched surfaces with soap and water.
- **Disinfect** by using at least 70% alcohol or a household bleach made by dissolving 5 tablespoons **bleach** in a gallon of water and leaving for at least a minute on surfaces. Bleach should, however, never be mixed with any other chemical and used with caution as it can damage skin and eyes.
- Clean **soft surfaces** like carpets, rugs and drapes with soap and water or disinfectants on the EPA list. **Reading** the label is important since different disinfectants have varying concentrations of active ingredients that require different 'contact times' to be effective.
- **Wrap** electronic devices in a plastic sheet or **wipe** them down with 70% alcohol or disinfectants.
- It may be prudent to wash your grocery bags but CDC or FDA does not recommend washing fresh produce with anything other than water.
- A recent study shows that the virus can last on masks for seven days implying that washing masks with soap and water before reusing them is important.

Executive Summary

Personal safety measures - food, packages, masks, disinfecting

On March 20, 2020, the FDA confirmed that there have been **no reports** of humans contracting COVID-19 by direct transmission through human food**,** animal food or food packaging. Foodborne transmission of SARS-CoV-2 is is not known to be a route of transmission.

According to the WHO and CDC, the risk of **contamination from packages** received by consumers is very low, since after having traveled for days and being exposed to various conditions of temperature and humidity it is unlikely that the virus is viable on the package.

For same day delivery, you may want to be cautious and continue hand washing for at least 20 seconds which is a consistent recommendation for handling any packages or materials that have been touched by others during shipping and handling.

However, being infected **from fomites** is definitely a possibility. It is estimated that a large number of asymptomatic infections resulted in a high viral attack rate in cruise ship passengers and crew members since SARS-CoV-2 RNA was found on cabin surfaces of both symptomatic and asymptomatic infected passengers for up to 17 days after cabins were vacated!

Though CDC had initially recommended wearing only medical-grade face masks for people infected with the virus and frontlines workers, experts now believe that wearing **homemade masks** in crowded places may prevent infection directly from aerosol particles and from touching the face.

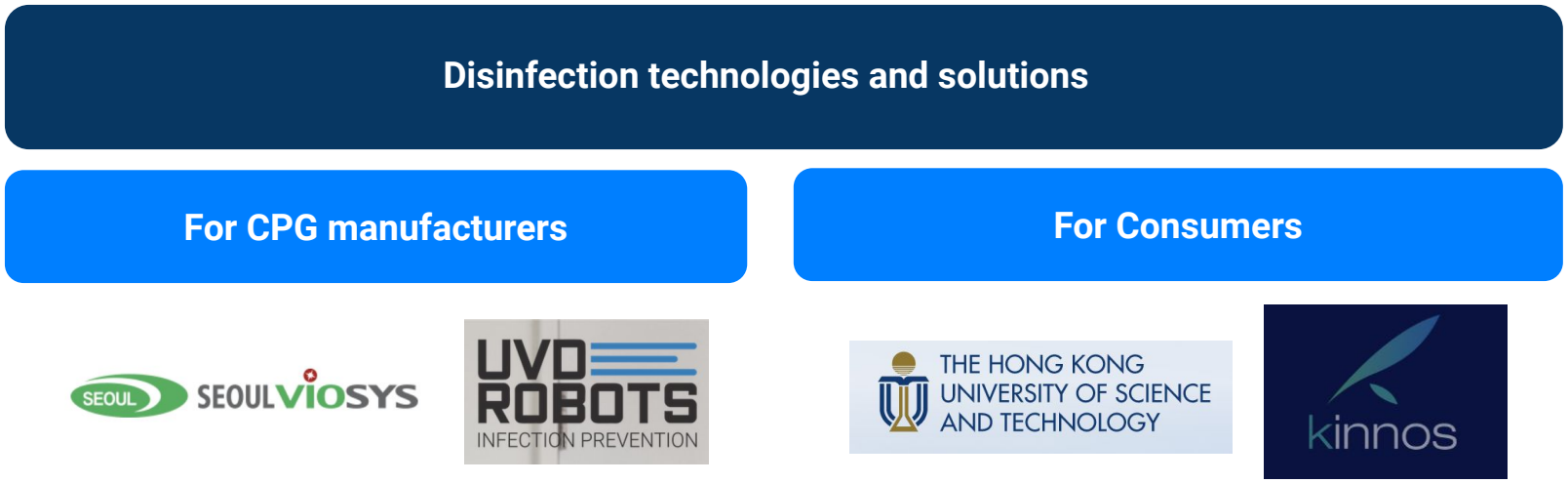
Executive Summary

Summary of Profiled Companies & Technologies

PreScouter investigated the current technologies that can be used by CPG manufacturers and identified measures that can be adopted by consumers to ensure that the virus does not spread through CPG goods.

This report provides examples of two types of disinfection strategies or technologies for manufacturers — **UV-based disinfection and mobile robotics** — as well as two types of preventive measures for consumers — **multilevel antibacterial polymer coating and a color-added disinfectant**.

The infographic below summaries the companies/academic centers that are profiled in this report.



For CPG manufacturers

Seoul Viosys

Founded: 2002

Headquarters: Republic of Korea

Website: http://www.seoulviosys.com/

Contact: +82-1566-2771

Overview

Since 2016, Seoul Viosys is a global provider of UVC LED, VCSEL (Vertical Cavity Surface Emitting Laser), the next-generation light source for 3D sensor and laser, a single-pixel RGB “Micro Clean Pixel” for displays and non-hazardous eco-friendly technologies for surface sterilization and water disinfection. With an extensive UV LED portfolio covering all wavelengths ranging from 200 nm to 1600 nm, including ultraviolet rays (UV), visible rays and infrared rays, and over 4000 patents, the company held top market share in the LED space in 2018. Violeds, its flagship UV LED technology, provides a wide range of industries with optimal solutions for strong sterilization and disinfection (UVC), skin regeneration (UVB), water/air purification and effective cultivation for horticulture.

At a glance			
Key Technology:	*Sterilization technology using UV LED*	**Stage of Development:**	*Commercialized*
COVID-19 response:	*Plan to launch portable clean products for 99.9 sterilization of all kinds of viruses and bacteria in air and surfaces*		

Seoul Viosys

Technology and Applications

Violeds, a compound semiconductor technology, is the brand name of technology that utilizes UV LED for sterilization and deodorization functions. Seoul Viosys is the only company in the world that can produce UV LEDs covering all UV wavelength range. It is an efficient and easy-to-use UV LED related product that can be used for UV curing systems in electronics, automobile and construction industries. It provides optimized deodorizing solutions to remove toxic gases from the air, based on violeds technology, accumulated R&D experience, and case studies. Their UV LED technology provides a low energy waterproof sterilization module with 99.9% efficiency for microbial decontamination from surfaces and water. The violeds technology has an optimized solution to attract and remove airborne pests such as mosquitoes and flies by controlling UV wavelength, intensity and radiation type.

Recent News

The Violeds technology, has been adopted by Yanfeng, a leading global automotive supplier will safely detect for absence of occupants before activating lamps for a period of 10 minutes that can sterilize the cabin including cockpit, seating and steering wheel. The sterilization lamp is embedded in the ceiling for maximum coverage and allows for sterilization of the harmful bacteria and viruses inside.

Seoul Viosys

COVID-19 Response

Seoul Viosys and Sensor Electronic Technology, Inc. (“SETi”) announced their success in achieving 99.9% sterilization of **coronavirus (COVID-19) in 30 seconds**. Tests were conducted with the **research group of Korea University**, by using a compound semiconductor Violeds technology that is being mass-produced.

With the goal to provide technology for a cleaner world, the company aims to minimize the spread of COVID-19, by offering strong sterilization solutions for coronavirus in air as well as surface of goods such as facial masks and smartphones.

The study also shows that the effect on the virus is stronger when placed closer to the photon with longer exposure time. In addition to testing the coronavirus, the Violeds technology also showed 99.9% sterilization of other harmful bacteria such as Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, Klebsiella pneumoniae, and Salmonella typhimurium.

References:

1. https://www.ledsmagazine.com/directory/led-packages/uv-ir-leds/press-release/14173719/seoul-semiconductor-seoul-viosys-violeds-technology-with-proven-999-sterilization-of-new-coronavirus-covid19-in-30-seconds-now-adopted-for-automotive-indoor-sterilization-solution
2. http://www.seoulviosys.com/en/

UVD Robotics

Founded: 2016

Headquarters: Odense, Denmark

Website: http://www.uvd-robots.com

Contact: +45 3110 7170

Overview

UVD Robotics was founded in 2016, following a public-private innovation project, where **Blue Ocean Robotics and Odense University Hospital (OUH)** in partnership with other hospitals in Denmark, developed the first prototype of the UV-Disinfection Robot. The mission was to integrate the approved UV germicidal industrial solutions with new advanced robotic technologies to create innovative products for eradicating harmful pathogens and superbugs in healthcare environments for safer hygienic operations, to help control hospital acquired infections affecting millions and killing thousands of people globally. Sold in more than 40 countries, UVD Robots is already delivering its self-driving disinfection robots to hospitals in parts of Asia in addition to healthcare markets in Europe and the United States.

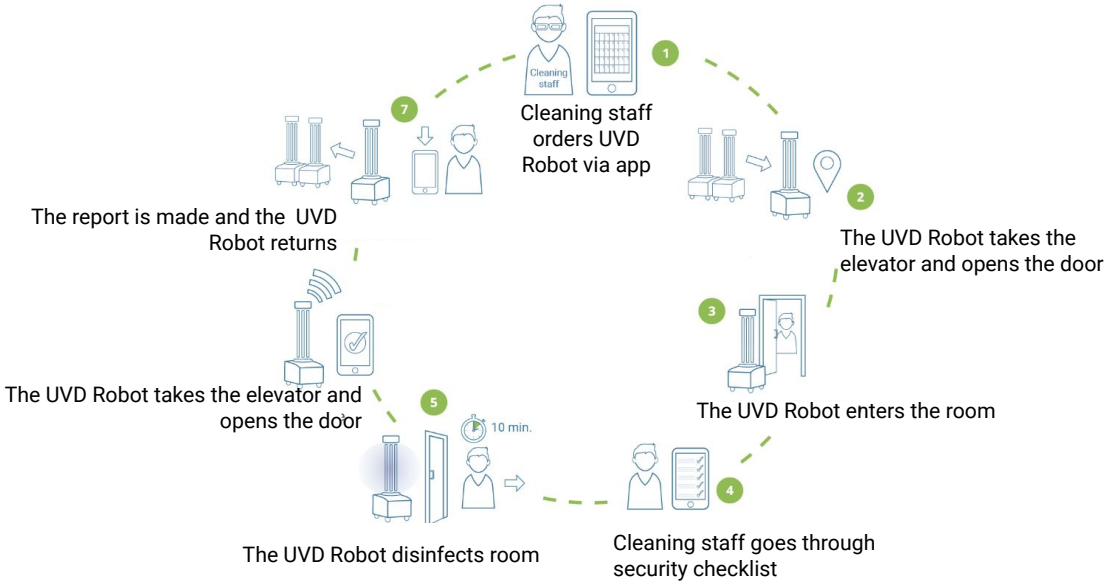
At a glance			
Key Technology:	*Integrating UVC radiation (254 nm) with an app controlled robotic technology*	**Stage of Development:**	*Commercialized*
COVID-19 response:	*Vast increase in demand particularly in Asia and Middle East*		

UVD Robotics

Technology

The UVD Robot is used as part of the regular cleaning cycle in hospitals, and aims at preventing and reducing the spread of infectious diseases caused by vira, bacteria, and other types of harmful organic microorganisms in the environment. The UVC radiation works by crosslinking DNA and eventually damaging the cells by breaking down their DNA-structure. The robot is safe, reliable, eliminates human error and disinfects 99.99% bacteria within 10 minutes. The robot is user-friendly and can be easily controlled using an app by the hospital staff.

Operating Process



UVD Robotics

COVID-19 Response

UVD Robots has been scaling up production to meet the rising demand triggered by the COVID-19 pandemic.

The co-founder and CEO of Blue Ocean Robotics, which owns UVD Robots, recently mentioned that they are facing overwhelming inquiries from resellers and new customers, with demand being highest in Asia and the Middle East. He also pointed out that they sold as many robots in three days as they did in their first year, indicating substantial growth of the company.

A Taiwan hospital estimated that the UVD Robot helped reduce the number of infections by 40-50% in both hospital staffers and patients.

References:

1. https://www.therobotreport.com/uvd-robots-responds-surging-demand-during-covid-19-crisis/
2. http://www.uvd-robots.com/
3. https://www.therobotreport.com/coronavirus-fight-china-gets-boost-uvd-disinfection-robots/

Supplementary Disinfection Technologies of Interest

- Next Science has received EPA approval for its non-toxic surface disinfectant. The disinfectant is the only EPA-approved product with a biofilm claim that is non-toxic to humans. The only required form of personal protection equipment (PPE) is safety glasses.
- In India, the army has developed a COVID-killing drone, equipped with a UV-light "gun".
- NTU Singapore researchers built a disinfection robot to aid cleaners in COVID-19 outbreak
- Units of Halosil's Halo Disinfection System, highlighted in "A new era of healthcare-associated infection (HAI) prevention", are being sent to China weekly in order to meet the country's immediate demand to disinfect healthcare facilities exposed to novel coronavirus pathogens.

For Consumers

HKUST

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Founded: 1991

Affiliation: Public University of Hong Kong

Website: https://www.ust.hk/

Contact: +852 2358 8888

Overview

Researchers from the HKUST, led by Professor Yeung King Lun, have developed a multilevel antimicrobial polymer (MAP-1) coating with an effective period of up to 90 days. This coating can inactivate up to 99.9% of highly-infectious microorganisms such as measles, mumps and rubella, as well as feline calicivirus (FCV) – a gold standard for disinfection efficiency, more resistant than coronaviruses. The MAP-1 coating ingredients can disrupt the microbial envelope thus making the pathogens non-viable upon contact. This unique blend of antimicrobial polymers can also prevent microbial adhesion to surfaces. The MAP-1 coating is non-toxic and can be safely used on different surfaces including metals, concrete, wood, glass, plastics as well as fabrics, leathers and textiles, without altering their look or feel.

At a glance			
Key Technology:	*Novel antimicrobial coating developed using a special blend of polymers*	**Stage of Development:**	*Commercialized*
COVID-19 response:	*Effective in Wuhan's Huoshenshan Hospital treating COVID-19 patients*		

HKUST

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Technology

In 2018, HKUST and Chiaphua Industries Limited (CIL) set up a joint laboratory with funding support from both CIL and the Innovation and Technology Commission (ITC) to translate innovative research ideas in environmental health technologies into commercial products to address societal needs. The development of the MAP-1 coating is the first prominent discovery of this venture.

The MAP-1 coating is a novel technology developed by the researchers, however, further details on how the technology was developed has not been revealed. All sources mention that the coating has been made by a special blend of polymers using materials that are non-toxic and thus can be widely used in clothing, surgical masks, bed linen, drapes as well as applied on a wide variety of surfaces. The coating is highly versatile with an effective period of up to 90 days.

Applications

In collaboration with its industrial partner CIL, HKUST has applied the antimicrobial coating to over 70 day-care centres, elder homes, kindergartens, primary and secondary schools, shopping malls, school buses, churches and sports training facilities.

The team is exploring the potential to apply its novel material to coat water pipes and sewage drains to prevent microbial contamination.

COVID-19 Response

The coating can effectively kill viruses, bacteria and even hard-to-kill spores. Recently, the coating has been found to be effective against the novel coronavirus and thus used in Wuhan's Huoshenshan Hospital, a 25,000-square-metre, 1000-bed hospital that was built specifically to treat patients with COVID-19.

In collaboration with Chiaphua Industries Ltd, the HKUST team developed MAP-1 as a potent solution for infection control. They ran a seven month field trial of the coating on privacy partition curtains in a local public hospital and six month study on bed linens in an elderly home. Their results showed the total amount of bacteria reduced by over 99 % and 95.8 % on the curtains and ben linens, respectively. This is very encouraging, as similar studies can be run in wards homing COVID-19 patients to prove the direct efficacy of this coating against SARS-CoV-2.

References:

1. https://www.asiabiotech.com/24/2404/24040056x.html
2. http://www.xinhuanet.com/english/2020-03/11/c_138867513.htm
3. https://www.ust.hk/news/research-and-innovation/hkust-develops-new-smart-anti-microbial-coating-fight-against-covid-19
4. https://www.createdigital.org.au/3-ways-technology-helping-fight-against-coronavirus/

Kinnos

Founded: 2014 **Headquarters:** New York, USA

Website: https://www.kinnos.us/ **Contact:** +1 978-314-3127

Overview

Kinnos, a New York based company founded by Columbia University graduates, wants to ensure its users attain thorough disinfection by allowing them to visualize the areas that have been cleaned. The startup's main product, **Highlight**, is a point-of-use additive that when combined with colorless disinfectants used in hospital and healthcare settings, make them appear blue when applied to a surface. The company claims that this greatly improves visibility, coverage, and end-user compliance of disinfectants. Highlight comes in two variations - the Highlight wipes and the Highlight powder.

At a glance			
Key Technology:	*Chemical ingredient added to standard disinfectants to impart color*	**Stage of Development:**	*Commercialized*
COVID-19 response:	*Dye currently being shipped to China*		

Kinnos

Technology

The **Highlight wipes** come as a patent protected two-part system with a lid and a cartridge. The reusable lid fits on all standard bleach wipe canisters. The cartridge is pre-filled with Highlight fluid and pre-installed with batteries. When used together, the lid and cartridge impart blue color to the wipes which helps track the coverage area before fading within minutes. The **Highlight powder** is a disinfectant additive that is compatible with existing bleach and chlorine sprays, such as standard 0.5% sodium hypochlorite, calcium hypochlorite, and sodium dichloroisocyanurate.

EPA has classified Highlight as an adjuvant and according to Kinnos, third party testings have shown that Highlight does not reduce the efficacy of disinfectants.

Applications

Their product is used by the Fire Department of New York and was the winner of the USAID Fighting Ebola Grand Challenge. Their product has also been field-tested by NGOs and healthcare workers in Liberia, Guinea, Haiti, DR Congo, and Uganda.

First hand reports from healthcare workers reveal a great interest in this product. 99% of responders reported a great improvement in visibility and coverage, 97% reported ease of use, and 100% reported preference over bleach or chlorine alone.

Kinnos

COVID-19 Response

Kinnos stemmed from participation in a design challenge held at Columbia University during the Ebola outbreak in 2014 in West Africa, when the founders wanted to improve the problem of ineffective decontamination pointed out by healthcare workers. The current COVID-19 pandemic triggered a new round of venture capital investment worth $6 million into this startup. This will help Kinnos get its products out in the US as well as set its foot in the global market.

Kinnos' signature dye is currently being shipped to China to help responders deal with COVID-19. Though the initial target has been hospitals, now with the pandemic and the current funding the company aims to take its products directly to consumers.

References:

1. https://techcrunch.com/2020/03/05/kinnos-which-makes-colorizes-disinfectant-to-ensure-surfaces-are-covered-just-landed-6-million-in-funding/
2. https://www.engadget.com/2020-03-05-kinnos-disinfectant.html

Supplementary Disinfection Technologies of Interest

- A plant-based cleaning product company, Boulder Clean, is currently awaiting EPA certification to provide households with a COVID-19 specific hard surface disinfectant made of thymol oil and citric acid. Boulder Clean hopes its EPA certification will be fast-tracked since it contains approved disinfectants from "List N: Disinfectants for Use Against SARS-CoV-2.". The company witnessed a remarkable 250% increase in its sales at its 7,500 retailers around the US in the month of March alone, due to the pandemic.
- Holista Colltech and Skin Elements have partnered to develop an alcohol-free hand sanitizer using a skin-sensitive anti-microbial formula with Path-Away, a plant-based alcohol green ingredient. It has proven successful in killing more than 170 viruses, bacteria and fungi.

Boulder Clean's "Citrus Breeze Hard Surface Disinfectant" is undergoing approval from the EPA as effective against COVID-19. Photo courtesy of 1908 Brands/Boulder Clean

About the Authors

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Daniel Morales

PreScouter

Professional Summary:

Daniel is an alumnus of the PreScouter's advanced degree researchers network and has worked with PreScouter for more than three years and on over 50 projects, spanning across areas such as innovation strategy and roadmapping, product and process improvement and development, sustainability, and technology trends throughout the CPG industry. Daniel earned his Ph.D. in Chemical Engineering from the NC State University, where his research focused on developing stimuli-responsive polymer networks for microrobotics applications. After his graduate studies, he completed postdoctoral work at INSA Toulouse, France where his work focused on the intersection of nanoparticle assembly, nanofabrication and microfluidics to develop novel sensors. Before joining PreScouter, Daniel gained industrial experience in pharma manufacturing, polymer processing and science manuscript editing, and he is based in Raleigh, North Carolina.

About the Authors

Paromita Raha

PreScouter

Professional Summary:

Paromita is a biotechnologist with a research focus on protein biochemistry, drug discovery, preclinical oncology, and food science. She earned her Ph.D. in Biotechnology from the University of Calcutta followed by postdoctoral research at the University of California, San Francisco. She has worked in the oncology drug discovery space overseeing multiple drug combinations translating to the clinic. A healthy eater and a strong proponent of sustainable environmental development, she currently leads food science research in a startup aiming to provide easy access to fermented food. Paromita is passionate about researching current technological innovations including market trends in the life and food sciences sector and presenting complex information in a simplified way to a global audience.

Next Steps

SOME POSSIBILITIES THAT PRESCOUTER CAN OFFER FOR CONTINUATION OF OUR RELATIONSHIP

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- ☑ TECHNOLOGY & PATENT LANDSCAPING
- ☑ TECHNOLOGY ROADMAPPING
- ☑ MARKET RESEARCH & ANALYSIS
- ☑ TRENDS MAPPING
- ☑ ACQUIRE NON-PUBLIC INFORMATION
- ☑ PATENT COMMERCIALIZATION STRATEGY
- ☑ DATA ANALYSIS & RECOMMENDATIONS
- ☑ REVIEW BEST PRACTICES
- ☑ SUPPLIER OUTREACH & ANALYSIS
- ☑ CONSULT WITH INDUSTRY SUBJECT MATTER EXPERTS
- ☑ INTERVIEWING COMPANIES & EXPERTS

WE CAN ALSO DO THE FOLLOWING

- ✔ **CONFERENCE SUPPORT:** Attend conferences of interest on your behalf.
- ✔ **WRITING ARTICLES:** Write technical or more public facing articles on your behalf.
- ✔ **WORKING WITH A CONTRACT RESEARCH ORGANIZATION:** Engage with a CRO to build a prototype, test equipment or any other related research service.

For any requests, we welcome your additional questions and custom building a solution for you.

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150,000+ HOURS OF RESEARCH COMPLETED FOR CLIENTS