Inactivation of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS Co-V2) Using Nanomolecular Silicon Dioxide Antimicrobial Solutions

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Abstract

The methods for sanitizing, cleaning, and disinfecting surfaces with standard chemical agents approved and recognized by the major regulatory agencies in the United States is widely understood and commonly performed. In most instances these chemicals are present at extremely high concentrations and can often create numerous health-related risks upon frequent contact and exposure. Until recently, options for protection against harmful pathogens present on inanimate surfaces always involved using large quantities of harsh and volatile chemicals that are most effective when wet and lose efficacy shortly after drying.

Today, a novel technology that utilizes a proprietary formula consisting of reengineered nanomolecular amorphous colloidal silica in combination with minimal amounts of agency approved inert and active ingredients has proven to not only be effective on contact but continues to protect surfaces long after it has dried. This technology was developed around 15 years ago and over that period has proven itself as both safe and effective. As the world is faced with yet another global pandemic the need for proven biocidal solutions is vital. The following information will explain the mechanism of action utilized by the microSURE technology and will go over the results seen when tested on different members of the coronavirus family including direct testing conducted on Severe Acute Respiratory Syndrome coronavirus 2 (SARS Co-V2), the virus responsible for causing the coronavirus disease 2019 (COVID-19).

Keywords: Coronavirus, Silicon dioxide, Antimicrobial, Microsure, Sanitizer, Virucidal

Abbreviations: SARS Co-V: Severe Acute Respiratory Syndrome Coronavirus; COVID-19: coronavirus disease 2019; MERS: Middle Eastern Respiratory Syndrome; QAC: Quaternary Ammonium Compound; BZK: Benzalkonium Chloride

Introduction

Over the past two decades, society has had to combat three extremely pathogenic coronaviruses that have all carried detrimental effects on the human population.(1-2) Coronaviruses are a family of viruses that are understood to cause illnesses which can vary from the common cold to severe diseases such as Middle Eastern Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS).(1-4) Current literature suggests that each of the mentioned coronavirus outbreaks originated from an animal source, the first (SARS-CoV) is said to have transmitted from civet cats in 2002, (MERS-CoV) is said to have transmitted from camels in 2012 and the novel (SARS-CoV2), the virus responsible for coronavirus 2019 (COVID-19) is said to have been transmitted from bats in 2019.(4-6) Both of the SARS associated coronaviruses have been linked to originating in China and MERS in Saudi Arabia, however all three members of the coronavirus family began to rapidly infect individuals throughout the globe and have collectively been responsible for hundreds of thousands of deaths.(7) Currently, there are no approved vaccines or antiviral drugs for the (SARS Co-V2) virus and because of this, having the ability to control and or contain the virus in order to limit dissemination is vital. It is for this very reason why proven solutions for sanitization, cleaning and disinfecting are eminent means of protection.

Literature Review

Although members of the coronavirus family share several commonalities, this literature will focus primarily on (SARS-CoV2). Transmission of the virus is predominantly spread from human to human via respiratory droplets, which are naturally expelled as an infected individual sneezes or coughs. (1-3) Recent studies have proven that the virus has the ability to persist on inanimate surfaces such as plastic, stainless steel and cardboard and can remain on these surfaces for days at a time.(3) Consequently, there is an obvious need for protective solutions which can be utilized on such surfaces to aid in defense against possible contamination. The microSURE technology is a solution that has consistently proven its capabilities throughout numerous verticals as a safe and effective biocidal agent.

The formula for this technology which was developed nearly 15 years ago by a neurosurgeon, was initially created to help decrease and eliminate bacterial infections that occurred secondary to surgical procedures. By developing a proprietary method involving the reengineering of amorphous colloidal silica so that the material stays inert while held in a stable aqueous solution and covalently bonds to a treated surface upon drying, this novel technology was not only found to be bactericidal but was also successful at destroying viruses, and eliminating mold, fungi and algae.(8) Once the microSURE technology is applied to a surface and allowed to dry, a 4-6 nm crystalline-like layer of Si02 covalently ('permanently') bonds to the underlying base substrate and creates a newly modified protective surface barrier (Figure 1). Due to the covalent bonding that takes place between the proprietary SiO2 and underlying base substrate, there is a clear understanding that in order to disassociate these bonds it would take a great deal of abrasion or visible soiling over of the surface itself until the Si02 is no longer in existence or considered biocidal.(9,10)

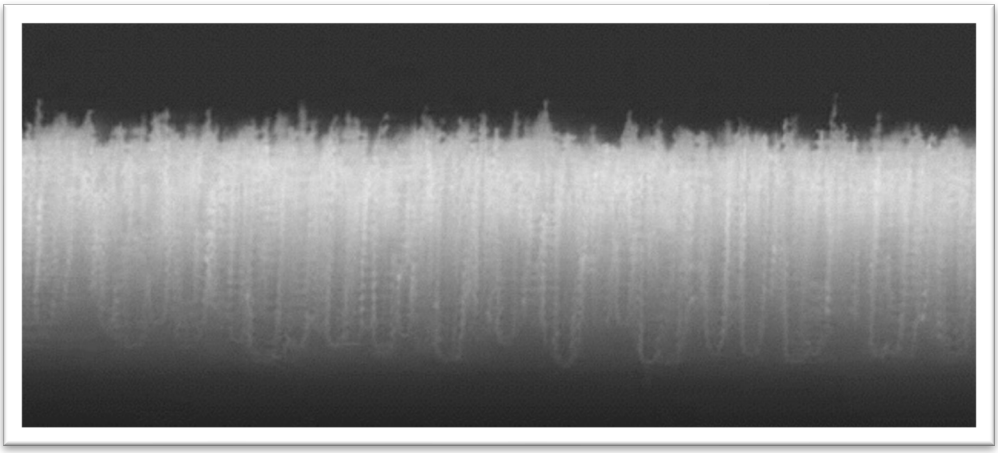

Figure 1: *Nanomolecular SiO2 crystalline-like structures visualized under high powered electron microscopy. Once dried onto a treated surface, the structures covalently bond to the underlying base substrate, creating a newly modified, antimicrobial, protective surface barrier.*

In a separate study completed at Iowa State University, testing concluded that an actual razor blade was necessary to dissociate the Si02 bonds from the treated surface, further proving the successful adhesion that takes place once this solution has dried onto a given surface (Figure 2).

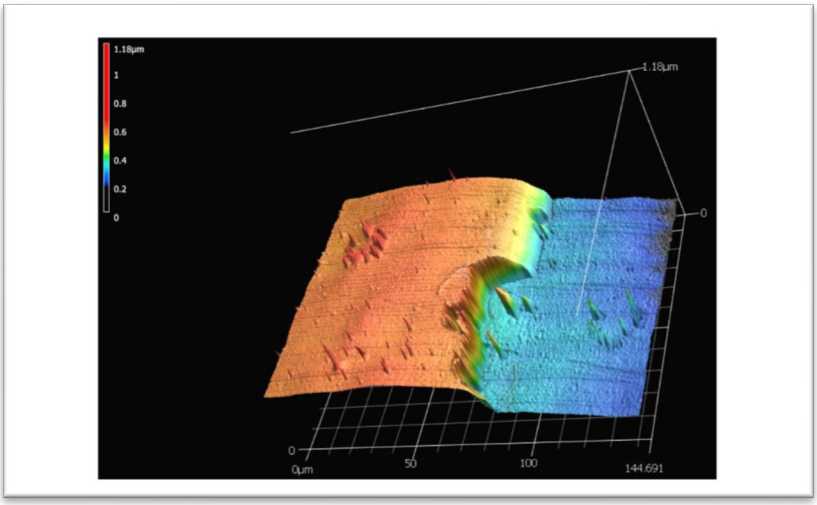

Figure 2: *Glass slide (3D image) taken from a study completed at Iowa State University under 100x magnification, showing slide treatment with microSURE , note the difference in surface height between the left and right sides after a razor blade was used to scrape off and dissociate the bonds that were present on the right side of the slide. Also, note the distinct pointed tips at the apex of each nanomolecular silicon dioxide structure that works to penetrate harmful pathogens that come into direct contact with the newly modified surface barrier.*

As it relates to (SARS Co-V2) there are very few antimicrobial solutions that have had the opportunity to perform direct testing on the virus itself, reasons for this are not only due to a lack of access to the virus but also because of the fact that this virus requires specific bio safety level laboratory clearance that must abide by agency approved standards to house such a harmful biothreat.

Materials and Methodology

The microSURE surface protectant (SP) solution is a blend of the IP technology with minimal amounts of quaternary ammonium compounds (CAS 85409-23-0, 68391-01-5)(QAC), while the microSURE hand and skin (HS) sanitizer consists of the IP technology and minimal amounts of benzalkonium chloride (BZK). In July of 2020, both solutions were chosen to begin direct testing on the (SARS Co-V2) virus here in the United States. The details below outline a general, broad spectrum, bullet point explanation of the protocol used for testing of both solutions against the virus.

- Plastic petri dishes were coated with the following treatments:
  - DiH20- Control deionized water (Negative treatment control)
  - microSURE™ Hand and Skin (HS) Sanitizer- Formulation of IP material and Benzalkonium chloride (BZK)
  - microSURE™ Surface Protectant (SP)- Formulation of IP material and Quaternary Ammonium

- The coating procedure was completed as follows:
  - 100mm and 60mm petri dishes were used to sandwich virus between treated surfaces
  - The inner bottom surface of 100mm dishes were filled with material, to completely cover the surface.
  - The bottom of a 60mm dish was placed in the material, exposing the bottom to the material.

- The petri dishes sat for 10 minutes and then the coating materials were removed and the dishes allowed to dry.
- Petri dishes were packaged in pairs with the 60mm dish inside the 100mm dish with the lid on the 100mm dish and stored at room temperature
- Coated Petri Dishes were coated approximately 3 hours before testing
- Coated surfaces were **not** tested for efficiency of coating.

- Coated materials were transferred for FFU assay and inactivation of SARS CoV-2 was tested according to specific protocol.

Results

Both of the tested microSURE solutions successfully reduced the average titer of SARS CoV-2 on treated plastic compared to di-H20-treated surfaces and demonstrated statistically significant reductions (**p<0.05** ANOVA, Krusjak-Wallis test, post hoc Dunn's multiple comparison test). Both microSURE Surface Protectant (SP) and microSURE Hand and Skin sanitizer (HS) treatments on the tested plastic surfaces were described as 'biologically relevant in terms of virucidal activity, reducing the infectious virus by at least **99.8%**'. The average FFU was decreased to less than 0.18% of diH20 FFU for microSURE SP and microSURE HS. The graphs below represent the outcomes seen after media recovery (Figure 3).

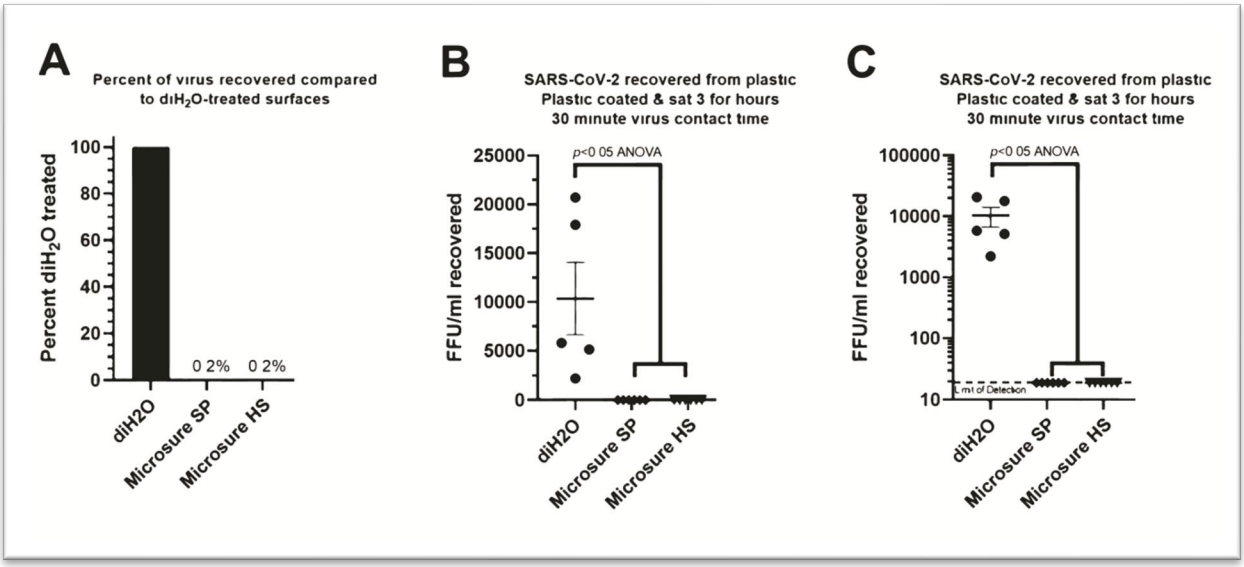

Figure 3: *Graph A represents the percent of infectious foci compared to diH20-treated slides. Graphs B and C represent the Infectious foci per ml of infection media recovered from the petri dishes after 30 minute contact time. The data above is presented in linear (**B**) and log (**C**) scale. Data presented in graphs A, B, and C are from the same experiment and do not represent repeated experiments.*

Preliminary conclusions stated that 'the coating method used (addition of material and/or dipping surfaces for several minutes contact time) was not tested to demonstrate efficient coating of the surfaces with the functional components of the microSURE materials' and proposed that there be improved or different coating methods used for upcoming testing, suggesting that future testing will likely demonstrate superior results than that which is already evident.

Conclusion

While (SARS Co-V2) is primarily transmitted from human to human via respiratory droplets, there is enough evidence to prove that the virus is more than capable of contaminating inanimate surfaces. Having access to a safer yet effective biocidal solution that has been tested directly against the virus and has proven to significantly eradicate the associated threat is crucial for the public during the current pandemic.

Although there are several hundreds of solutions that have tested against surrogate viruses similar in structure to (SARS Co-V2), microSURE SP and microSURE HS are among the select few that can provide direct (SARS Co-V2) efficacy findings. It is also important to note that prior to this testing, the (QAC 85409-23-0 and 68391-01-5) present within the microSURE surface protectant solution was also recognized for effectively destroying the original (SARS Co-V) that made its impact back in 2002. (11)

As businesses, schools, and individuals all around the world attempt to get back to a 'normal way of living' it is evident that the use of sanitizers, cleaning agents and disinfectants is increasing tremendously. Unfortunately, many of these end users are not aware of which solutions have conducted direct testing against (SARS Co-V2) and has proven to be effective. The increased use of harmful and volatile chemical agents and the excessive applications of these chemicals continue to create health concerns on a global scale. By using alternative options that contain minimal amounts of active chemical ingredients such as those present within microSURE SP and microSURE HS, this risk can easily be reduced.

As stated previously, both microSURE SP and microSURE HS demonstrated biologically relevant findings in terms of virucidal activity, reducing (SARS Co-V2) by at least **99.8%** and further proving the capabilities of the technology associated with the microSURE solutions. These findings aid in providing the data that is essential to confirming that both microSURE SP and microSURE HS are undeniably beneficial in terms of protection from (COVID-19) as it relates to contact contamination between inanimate surfaces and the human skin.

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