Virustatic® Shield™ AVM96

Anti-viral 360° Protective Face Mask

Science behind the Shield

Version SBS001 13/4/20

virustatic® SHIELD by edelweiss DENTISTRY

Introduction to the Virustatic Shield

Viruses are transmitted via airborne aerosols. They bind onto receptors on the surface of cell membranes in the upper and lower respiratory system, causing infection.

The use of respirators and face masks is a key part of a larger strategy to reduce the spread of viruses by establishing barriers between infected and uninfected individuals. The Virustatic Shield respirator has a role in both clinical care and community settings against the transmission of airborne viruses and bacteria. The reusable Shield is the only respirator designed to be antiviral and uses coatings containing natural proteins to bind and disable pathogens before they are inhaled.

Existing masks are hydrophobic and are designed to provide a barrier so that liquid particulates or splatter, such as mucus and blood, are caught on the surface of the mask. These particulates and splatter remain live on the surface of the mask and can go on to cause infection when the mask is touched or removed. Additionally, the build-up of these active particulates on the surface of the mask leads to a high and increasing pressure drop which:

- Limits how long they can be used
- Draws in contaminated viral aerosols around the edges
- Requires the mask to be fit tested
- Reduces oxygen levels causing headaches and fatigue

Virustatic Shield research has enabled protein coatings to be introduced onto hydrophilic materials that bind and render influenza viruses in aerosols inert on contact. The Virustatic Shield uses natural proteins that contain sialic acid. The protein coating acts in the same way as mucus by capturing the virus. Unlike mucus, it then goes on to incapacitate the virus by binding to the sialic acids contained within it.

In addition, the protein coating's antimicrobial peptides have a cationic property which disrupts and inactivates the influenza virus contained in aerosols which are normally small enough (<3 µm) to pass through material used in existing masks. The coating's MeSH Pharmacological Classification is as an Anti-Infective Agent. It classifies as a substance that either prevents infectious agents or organisms from spreading, or, kills infectious agents in order to prevent the spread of infection. The protein in the Virustatic Shield is well known for its cationic action against viruses and bacteria.

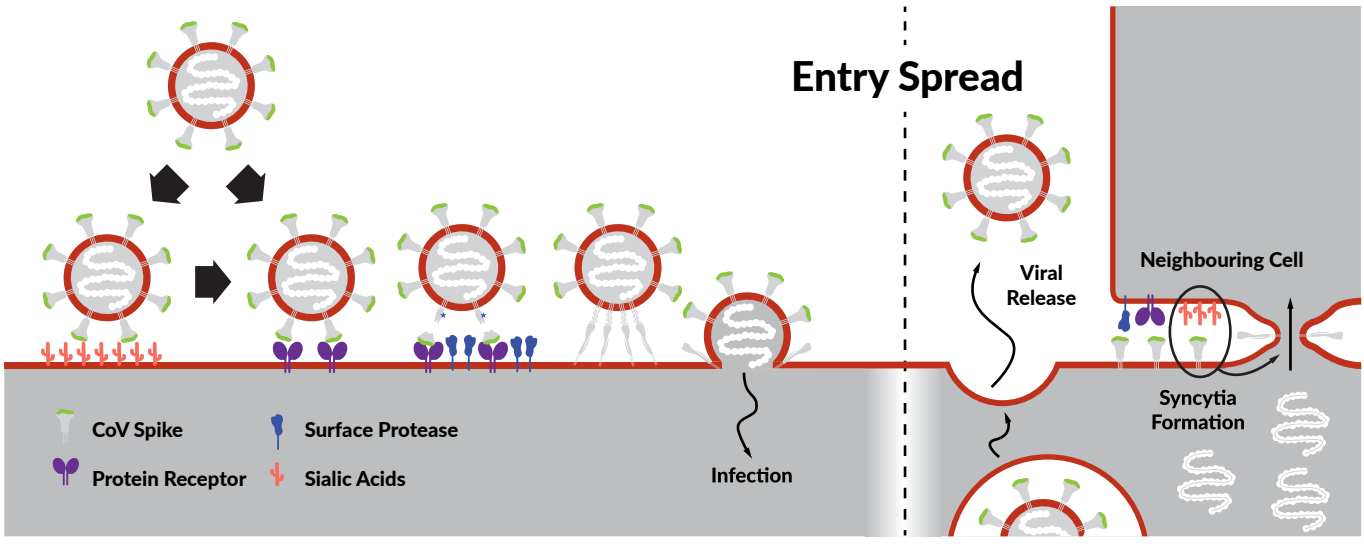

Figure 1. The diagram explains how Covid-19 initially binds to sialic acid and the process it has to go through in further bindings to infect. The Influenza virus has been proven to bind to the sialic acids on the proteins that are on the both surfaces of the shield.

Virustatic Shield tests demonstrated that this cationic action is responsible for up to 35% viral inactivation through the mask. Viruses are fragile protein molecules, wrapped in a protective layer of protein, known as the viral envelope. This protective 'viral envelope' is negatively charged. Virustatic coating proteins are cationic (positively charged) and disrupts the negatively charged viral envelope.

The destabilised viruses cannot infect cells and they decompose.

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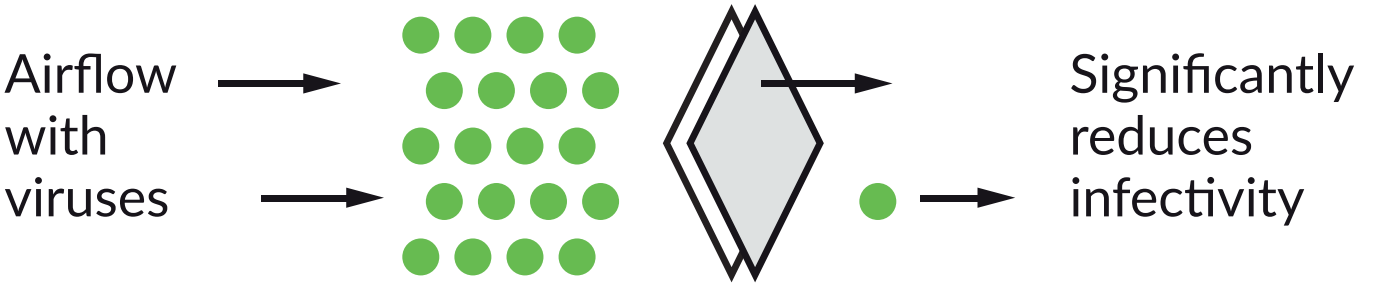


Figure 2. Fabric coating's cationic property disrupts the viral envelope. Coating mimics the body's own cells to bind with viruses.

The science behind the Shield

The increased transmission of 2019-nCoVhuman can be explained by the utilisation of human upper respiratory tract receptors Neu5ac SA α2,6 implicated in historic coronavirus transmission. Therefore, the Virustatic coating containing sialic acid Neu5ac SA α 2,6 would bind the virus on the mask surface, similar to Influenza C.

The Virustatic Shield delivers cationic disruption of the coronavirus envelope. The protein's antimicrobial peptide cationic properties disrupt and inactivate viruses contained in aerosols normally small enough (<5 µm) to pass through material used in the Virustatic Shield.

Independent University testing

Following significant testing at Manchester University in 2011, 2013 and 2017 on materials and proteins that were shown to be potentially capable of stopping the infectivity of Influenza, Virustatic tested the concept against live Influenza viruses.

In December 2017, at a leading UK hospital university laboratory, Virustatic carried out preliminary testing on the ability of materials coated with [Virustatic's patented coatings] to block the passage of airborne influenza viruses. Virus generation was by nebulisation using an Aerogene nebuliser that generated a mean diameter droplet size of 5 micron. Nebulised droplets were pushed through filters using an air pump. The filters contained different materials, or no material, and any virus that passed through was collected onto phosphate buffered saline using impingers. Infectious viruses from the fluid in the impinger were titrated by performing a plaque assay on MDCK cells.

In 2018, Virustatic completed further testing using that same procedure on a total of ten materials.

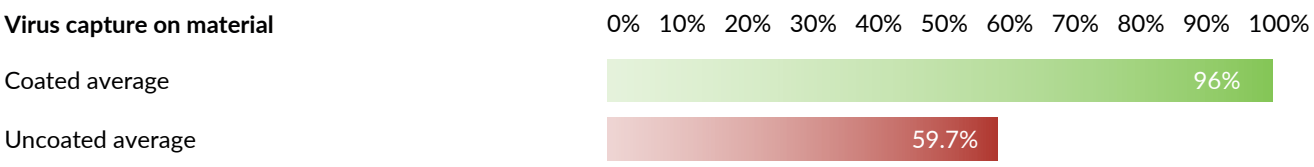
A standard dose (1x107 pfu) of a virus typical of the most recent pandemic, pH1N1 2009 (strain A/England/195/2009) was nebulised and the airborne droplets containing infectious virus were passed through four different outlets, each containing a different material or no material at all. Virus infectivity that passed through the in line filters with or without Virustatic material was then assessed by collection with an impinger and plaque assay on MDCK cells.

The amount of infectious virus that passed through each material were compared with each other and also with the amount of virus collected in absence of any material, and the amount of virus that passed through a filter containing an FFP3 face mask material as a positive control. Each condition was performed in triplicate, by running three experiments on three separate days.

Summary

The results indicated that the coating substantially improves the capture rate of the influenza virus, versus non-coated materials chosen for the Shield. The difference between the uncoated and coated materials demonstrates the cationic effects. The results demonstrated a greater than 96% disinfection of the virus as a result of the combined effects of the binding of the virus and the cationic eradication.

Test Results



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Sample 5

08.06.2018

Sample No	Coated/Blank	Description	Replicate	Dilution	No. of Plaques	PFU mL^{-1}	Avg PFU mL^{-1}	Viral Capture % of Blank Line
Empty			1	1.00E-02	23	2.30E+04	15000	
			2	1.00E-02	7	7.00E+03		
9	Blank	Sample 5	1	1.00E-02	12	1.20E+04	11500	20.000
			2	1.00E-03	11	1.10E+04		26.667
9B	coated 1%	Sample 5	1	0.00E+00	40	4.00E+02	350	98.261
			2	0.00E+00	30	3.00E+02		95.714

23.06.2018

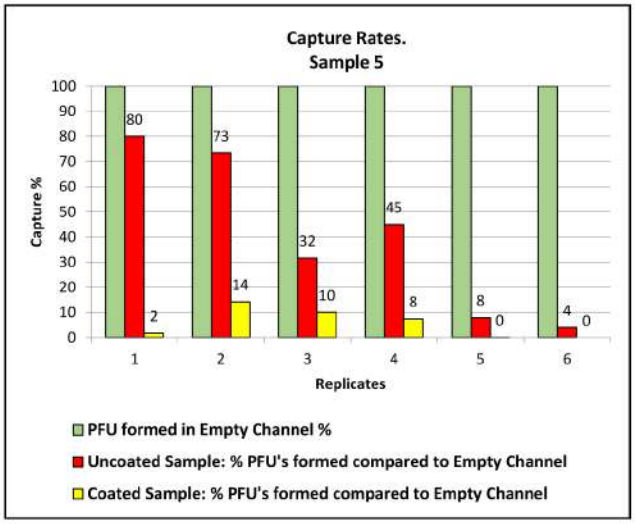
Empty			1	1.00E-02	6	6.00E+03	5000	
			2	1.00E-02	4	4.00E+03		
9	Blank	Sample 5	1	1.00E-01	19	1.90E+03	1850	68.333
			2	1.00E-01	18	1.80E+03		55.000
9B	coated 1%	Sample 5	1	1.00E-01	6	6.00E+02	450	90.000
			2	1.00E-01	3	3.00E+02		92.500

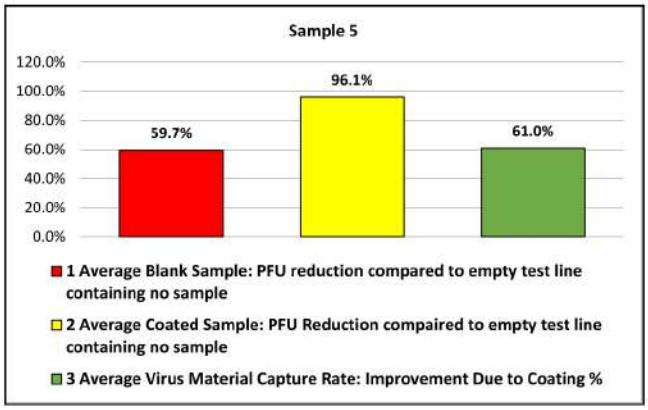
09.07.2018

Empty			1	1.00E-03	1	1.00E+04	10000	
			2	1.00E-03	1	1.00E+04		
9	Blank	Sample 5	1	1.00E-01	8	8.00E+02	600	92.000
			2	1.00E-01	4	4.00E+02		96.000
9b	coated 1%	Sample 5	1	0.00E+00	1	1.00E+01	5	99.900
			2	0.00E+00	0	0.00E+00		100.000

PFU Formed in Empty Channel	23	7	6	4	1	1
PFU formed in Empty Channel %	100	100	100	100	100	100
Uncoated Sample: **% PFU's formed** compared to Empty Channel	80	73	32	45	8	4
Coated Sample: **% PFU's formed** compared to Empty Channel	2	14	10	8	0	0

1	Average **Blank** Sample: PFU reduction compared to empty test line containing no sample	59.7%
2	Average **Coated** Sample: PFU Reduction compaired to empty test line containing no sample	96.1%
3	Average Virus Material Capture Rate: **Improvement** Due to Coating %	61.0%





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