HEIQ VIROBLOCK

Antiviral & Antibacterial protection

14 April 2020

SWISS TECH INSIDE

HeiQ Viroblock NPJ03

HeiQ development laboratories

Zürich, Switzerland & Concord, North Carolina USA

- State-of-the-art textile testing & development laboratories
- Our dedicated team of textile chemists offers product development, customized solutions & testing services

Laboratory capabilities

- Chemical reactions
- Polymer synthesis
- Chemical formulations
- Particle milling
- Analytics
- QC
- Recipe development
- Textile application
- Textile testing
- Membrane testing
- Antimicrobial testing
- VOC testing
- Pilot plant textile application
- *heiQ it!* fabric library

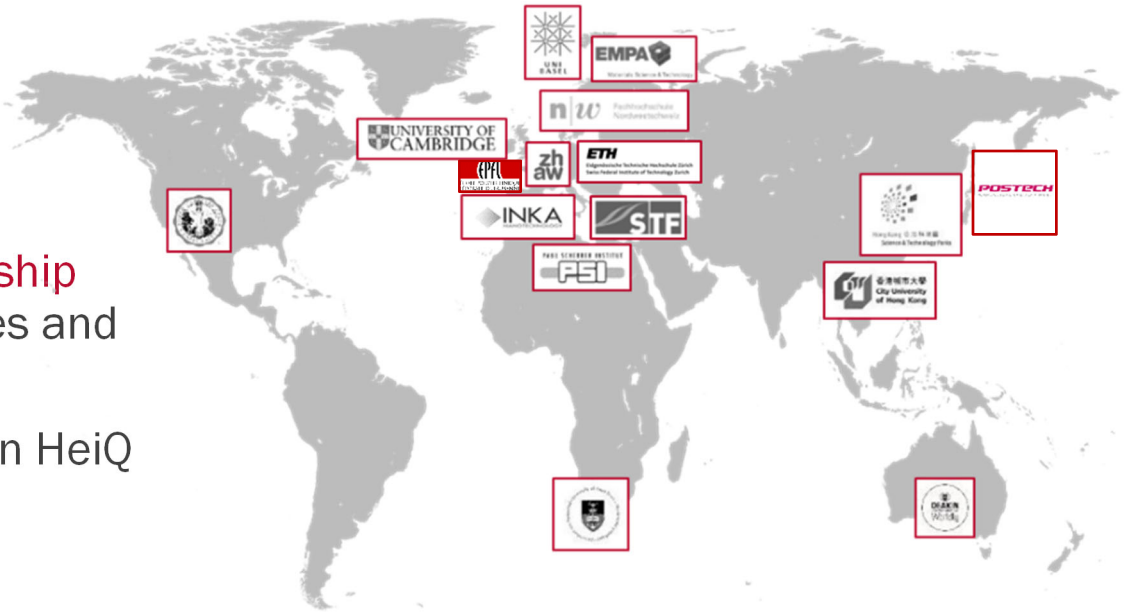
HeiQ research network

HeiQ internal product development team of 12 chemists

HeiQ achieves its research objectives primarily through a boundless research network

HeiQ sparks engaged partnership with researchers at universities and institutes around the world

Today dozens of PhD's work on HeiQ projects



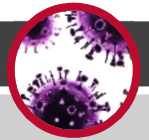
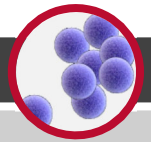
HeiQ scientific board

Martin Loessner Prof. Dr.	ETH Zürich Switzerland	Microbiology & food sciences
Clemens Holzer Univ. Prof. Dipl. Eng. Dr. mont.	Montanuniversitaet Leoben Austria	Polymer science & processing
Hyung Gyu Park Prof. Dr.	POSTECH South Korea	Nanotechnology & process engineering
Thierry Pelet Dr.	EPFL Lausanne Switzerland	Molecular biology & virology
Wey Yang Teoh Dr.	Australia	Nanotechnology & Photocatalysis
Hendrik Tevaearai Prof. Dr. med., EMBA HSG	Switzerland	Cardiology & medical sciences
Paul Collins Assoc. Prof. Dr.	Deakin University Australia	Engineering & sports physiology
Alessandra Sutti Assoc. Prof. Dr.	Deakin University Australia	Biomaterials & materials science

HeiQ key innovation families

What is the issue?

What are viruses and bacteria?

	Viruses 	Bacteria 
Definition	▪ Infectious substances ▪ Usually infect specific cell types (of plants, animals, humans) ▪ Mostly harmful and can cause diseases	▪ Single cell organisms ▪ Natural part of environment, and present in large numbers inside and on the outside of the human body ▪ Mostly harmless, but some bacteria can cause harmful diseases
Types	▪ Enveloped *(by a lipid, fatty membrane), more than 60% of all existing viruses* ▪ Non-enveloped	▪ Gram positive ▪ Gram negative
*Size**	20-300 nm	About 1‘000 nm
Replication	By invading a living host cell which replicates and releases the new viruses	Rapidly by cell division
Examples	Coronavirus, Human and avian influenza virus (H1N1, H5N1), Herpes simplex virus, Hepatitis virus, HIV	*Gram pos.:* Staphylococcus aureus, MRSA ("golden staph"), MSSA; *Gram neg.:* Escherichia coli, Klebsiella pneumoniae, Salmonella typhimurium
Diseases	COVID-19, Influenza, Chickenpox, SARS, AIDS	Food poisoning, Meningitis, Pneumonia

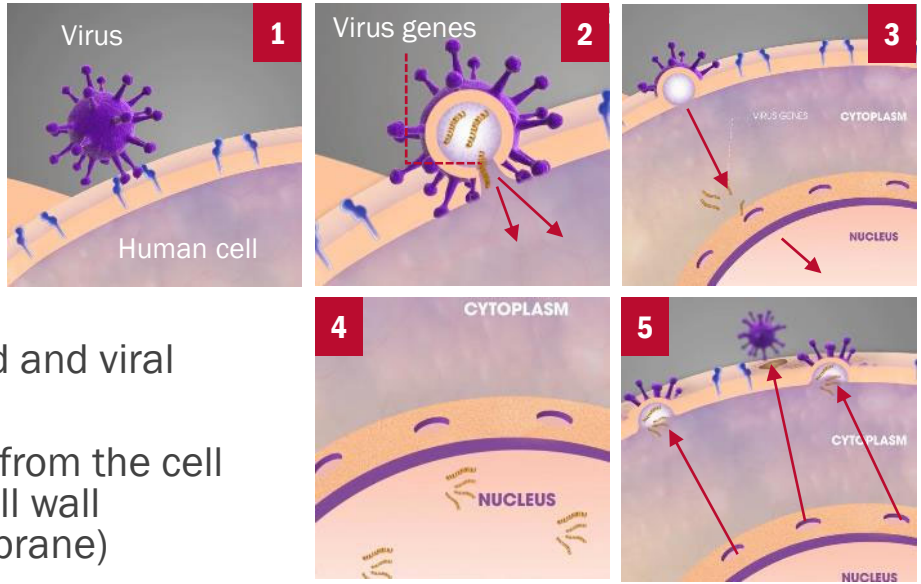
* Lakna, «Difference Between Bacteria and Virus», 2017, Pediaa

Key steps in the virus replication cycle

- Viral infections are governed by complex interactions between the virus and host cells
- All viruses depend upon a host cell for their protein synthesis and replication

Key steps[1]:

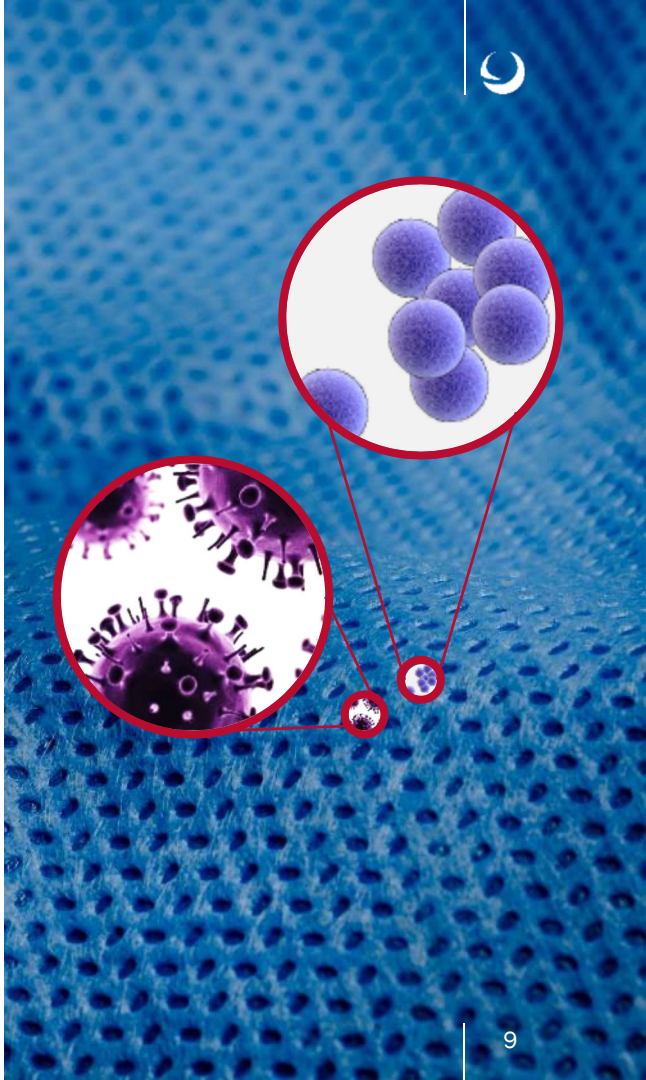
1. Binding: Virus binds to the host cell
2. Entry: Virus or its genome enters in the host cell
3. Uncoating: Genome leaves its protective capsid
4. Replication: Genome is transcribed and viral mRNA directs protein synthesis
5. Release: New virions are released from the cell and being “coated” with human cell wall components, the pericapsis (membrane)



[1] Galdiero, S. et.al.., 2011. Silver nanoparticles as potential antiviral agents. Molecules, 16(10), pp.8894-8918.

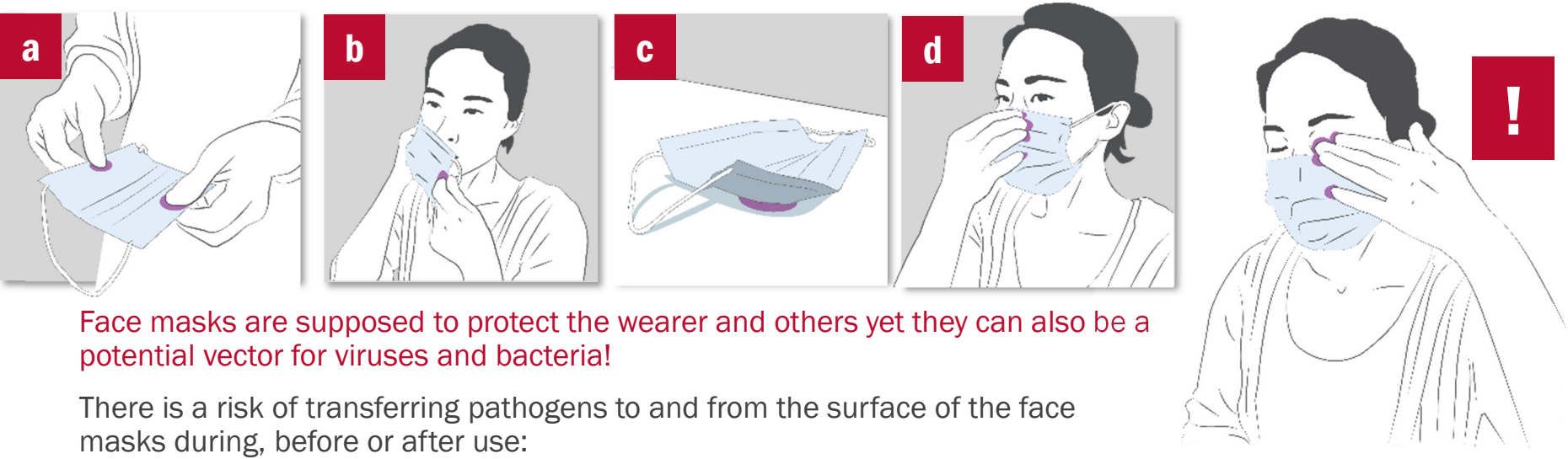
Infection & transmission

- Many viruses and bacteria are pathogens that can lead to severe sickness and mortality
- Textiles provide a large hosting surface area for bacteria and viruses, benefiting their carryover
- Thousands of deaths every year can result from transmission of pathogens [1)]
- Viruses and bacteria can remain active on textile surfaces from days to months [2]
- E.g. Research has shown that the human coronavirus (SARS-CoV) can persist for up to 2 days on surgical gowns at room temperature.[3]



1) K.Sack “Hospital Infection Problem Persists”, New York Times (April 13, 2010).
2) A.Kramer, I.Schwebke, G.Kampf (2006) "How long do nosocomial pathogens persist on inanimate surfaces? A systematic review", BMC Infectious Diseases, 6(130).
3) Kampf, G., Todt, D., Pfaender, S. and Steinmann, E., 2020. Persistence of coronaviruses on inanimate surfaces and its inactivation with biocidal agents. Journal of Hospital Infection.

Face mask: a potential vector for cross-contamination



Face masks are supposed to protect the wearer and others yet they can also be a potential vector for viruses and bacteria!

There is a risk of transferring pathogens to and from the surface of the face masks during, before or after use:

- **a** When picking it up
- **b** When putting it on or taking off
- **c** When disposing it unsafely or leaving it laying around
- **d** When touching it while wearing or for adjustment

! There is always the risk to contract the virus through touching the face after touching the contaminated surface of the mask or other contaminated surfaces!

What is the solution?

HeiQ Viroblock NPJ03 – antiviral textile technology

- Effective protection against contamination and transmission of viruses and bacteria that use textiles as a hosting surface
- Kills bacteria and destroys viruses in minutes
- Effective against common harmful enveloped viruses such as influenza and coronavirus
- Breakthrough combination of two leading HeiQ technologies:
  - HeiQ's registered silver technologies for antiviral and antibacterial effect
  - HeiQ's fatty vesicle technology as a booster that destroys viruses
- Harnesses the natural antiviral and antibacterial properties of silver

Technical USPs

- ✓ Non-dangerous good: logistics and storage convenient
- ✓ Can be applied to all types of fabrics and nonwovens
- ✓ Standard continuous wet-processing applications (padding, kiss-roll etc.)
- ✓ Application 5% to 20% w.o.f.

OEKO-TEX® CONFIDENCE IN TEXTILES STANDARD 100

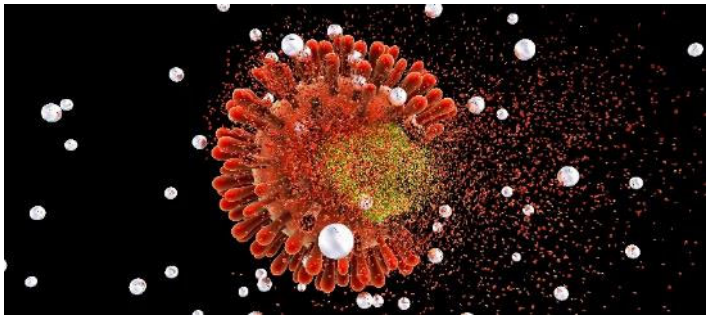
bluesign®

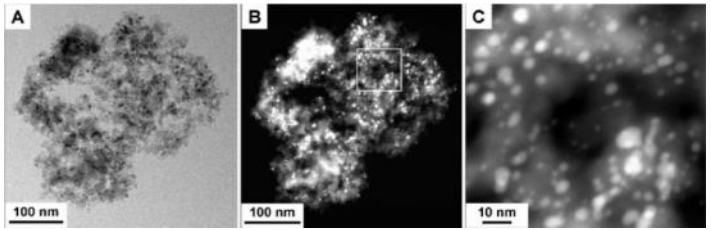
ZDHC

Oekotex, Bluesign, ZDHC: pending for approval

HeiQ Viroblock – Silver component

- Small silver particles are potent antibacterial and antiviral agents due to high surface area to volume ratio and unique chemical and physical properties [5)]
- Small silver particles are effective against viruses, effectively eliminating them following short exposure of isolated viruses to silver [5)]
- Silver attracts the oppositely charged viruses and binds permanently to their sulfur groups
- HeiQ small silver particles contribute to a broad-spectrum of antiviral mechanisms that are not prone to inducing resistance



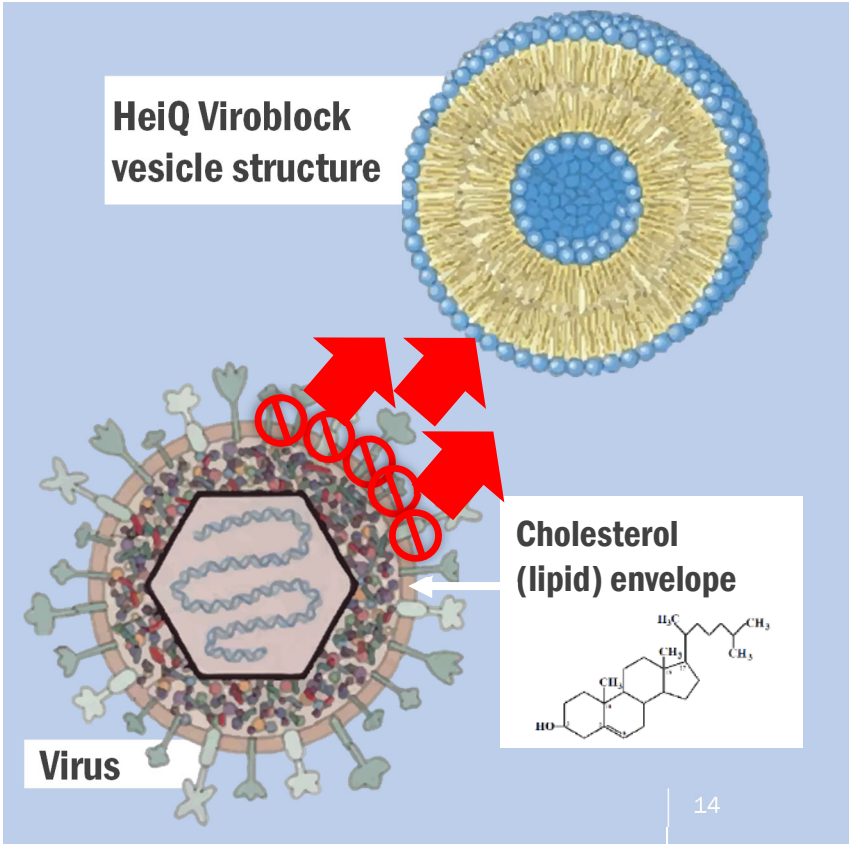


A) Transmission electron micrograph showing an amorphous silicon dioxide aggregate particle (gray structure) together with numerous supported silver metal particles (dark spots). (B) Scanning transmission electron micrograph of the structure shown in panel A, providing better contrast between the silica structure (gray) and the silver metal particles (bright spots). (C) Higher magnification of the region in panel B enclosed in a box. The silver metal particles are typically between 1 and 10 nm in diameter. 6)

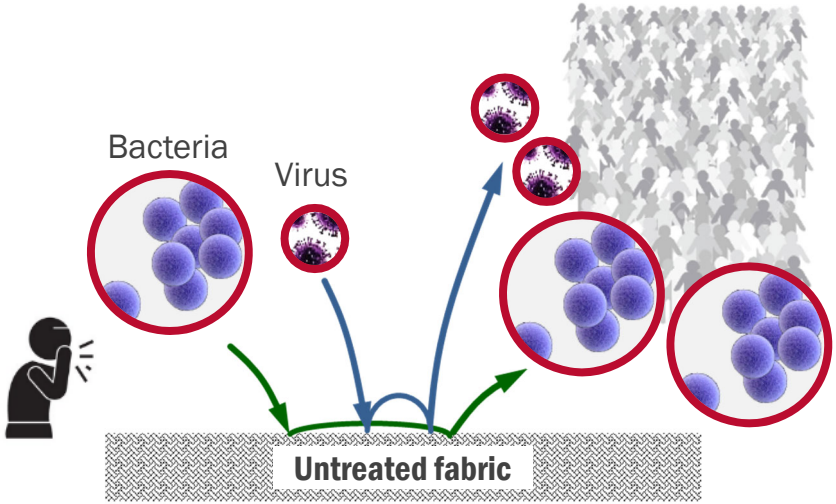
5) Stefania Galdiero et. al. (2011) “Silver Nanoparticles as Potential Antiviral Agents”, molecules 2011, 16, 8894-8918.
6) Egger et. al., 2009. Antimicrobial properties of a novel silver-silica nanocomposite material. Appl. Environ. Microbiol., 75(9), pp.2973-2976.

HeiQ Viroblock – Vesicle component

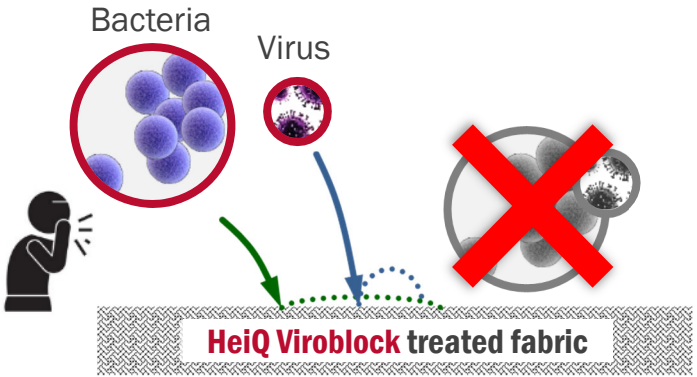
- HeiQ Viroblock vesicle technology (Liposomes) works as a booster
- The fatty spherical vesicle technology functions by directly targeting the lipid envelope (membrane) surrounding the virus
- The vesicle technology helps to deplete the viral membrane of its cholesterol content thereby destroying the virus
- The vesicles rapidly destroy the virus through a physical contact mechanism



How does it work?



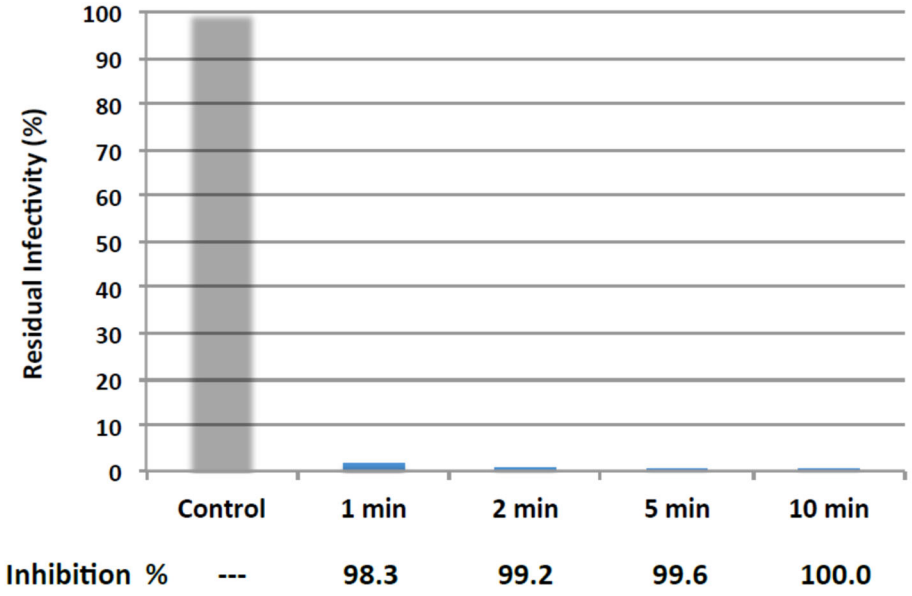
- Textiles provide an ideal surface for harboring viruses and bacteria
- Over the time, viruses and bacteria be re-transmitted from the textile (eg. contact with other surfaces)



- Textiles treated with HeiQ Viroblock actively inhibit viruses and kill bacteria upon contact
- By keeping the textile free of viable viruses and bacteria, **HeiQ Viroblock** treated textiles **help to minimize the potential for re-transmission of pathogens from textiles**

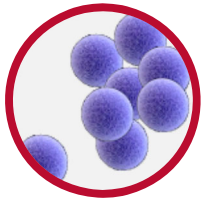
Antiviral effect on Sendai virus

- Nonwoven fabric treated with HeiQ Viroblock NPJ03
- Residual virus infectivity tested according to a modified ISO 20743 method (Sendai)



Rapid **ANTIVIRAL** effect demonstrated within 2 to 5 minutes

Antibacterial effect on Staphylococcus aureus



- Polyester fabric treated with HeiQ Viroblock NPJ03
- Time series effectiveness based on modified ISO 20743 test method

Kill rate for Staphylococcus aureus over time:

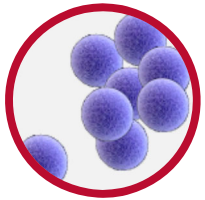
Sample # 326-1-1					
Contact time [min]	0	15	20	30	60
cfu control	4.35×10^5				5.17×10^5
cfu sample		6.63×10^4	2.23×10^3	6.93×10^2	$\leq 9.9 \times 10^1$
log reduction		0.8	2.3	2.8	3.6
% reduction		84.74%	99.49%	99.84%	99.98%

The theoretical limit of detection is 100 CFU

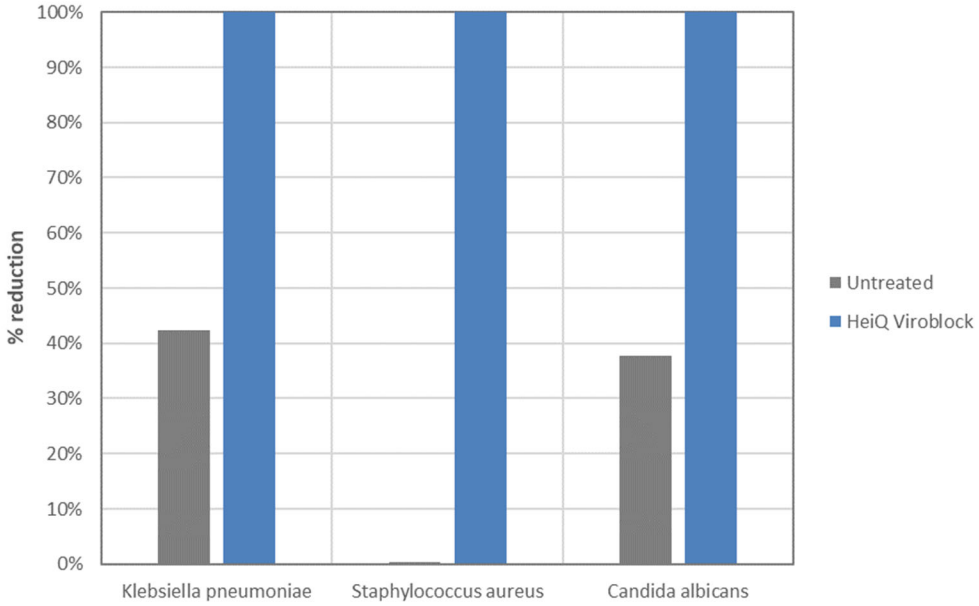
>99% effect against *Staphylococcus aureus* within 20 min

Rapid **ANTIBACTERIAL** effect demonstrated within 20 to 30 minutes

Antibacterial effect on bacteria



- Nonwoven fabric treated with HeiQ Viroblock NPJ03
- Antibacterial activity tested according to ISO 20743



Broad spectrum activity against *gram negative* and *gram positive* bacteria (and yeast)

Droplet breakthrough

- A cough can release around 100,000 droplets into the air [1)]
- A scenario of a mask exposed to all 100,000 droplets yields different resulting numbers of viable virus droplets passing through:

Mask	Log reduction [2]	% reduction	Viable droplets passing through mask
FFP2 control	3.63	99.9766%	>23
FFP2 & HeiQ Viroblock	5.38	99.9996%	<1

!

HeiQ Viroblock treatment enhances the level of virus protection for masks by >10 times

1) Gerone, P.J., Couch, R.B., Keefer, G.V., Douglas, R.G., Derrenbacher, E.B. and Knight, V., 1966. Assessment of experimental and natural viral aerosols. Bacteriological reviews, 30(3), p.576.
[2) Viroblock, Aerosol study 798-110

How can HeiQ Viroblock be tested?

HeiQ Viroblock test methods & guidelines

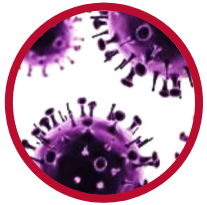
- Antibacterial efficacy is validated through antibacterial tests
- For validation of the antiviral efficacy of treated articles, following procedure is recommended:

Step 1	**Silver content analysis**	HeiQ inhouse method (amount of silver content on the finished textiles is analyzed)	HeiQ can support
Step 2	**Antibacterial test**	Yogurt Bac express antimicrobial qualitative test *OR* ISO 20743 antimicrobial test with Staph. A.	HeiQ can support
Step 3	**Antiviral test**	ISO 18184	External testing laboratory (HeiQ does not perform any antiviral test)

*Contact HeiQ for recommended testing laboratories performing the ISO18184 test method!

Antiviral efficacy test: ISO 18184

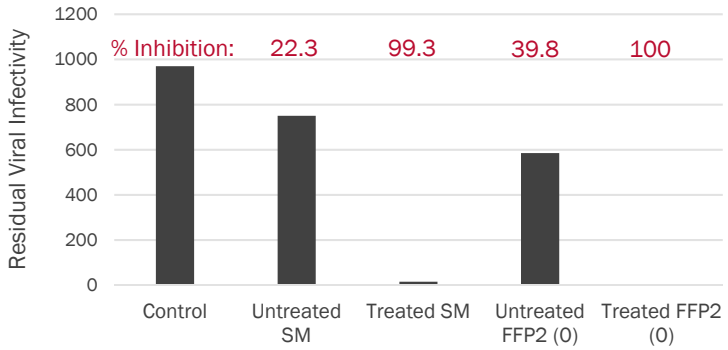
Testing for antiviral efficacy



Antiviral efficacy test (ISO 18184)

Determination of antiviral activity of textile products

- ISO 18184[1)] measures the property to give the morphological change or structural damage to the surface protein of virus
- A reference cloth used to verify the stability of the test virus on a textile fabric
- Infectivity titre of virus is measured with the number of infectious viral particles present per unit volume in a cell lysate or in a solution



96 wells microplate for TCID50 method

Please consult your local testing laboratories to carry out ISO18184 tests if needed

1) ISO 18184:2019, Textiles — Determination of antiviral activity of textile products, International Organization for Standardization (ISO)

Antiviral efficacy test results (ISO 18184)

Nonwoven* material for disposable masks treated with HeiQ Viroblock NPJ03:

ID	Agent	Log reduction	% reduction
LS20-00319-6	H3N2 (Human Influenza A)	4.72	99.99%

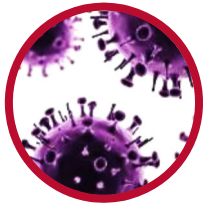
The HeiQ ViroblockNPJ03 treated nonwoven material shows **excellent antiviral efficacy!**


广东省微生物分析检测中心
GUANGDONG DETECTION CENTER OF MICROBIOLOGY
分析检测结果
ANALYSIS AND TEST RESULT

*FA2040 nonwoven material

Aerosol challenge test: ASTM F2101

Testing for antiviral efficacy

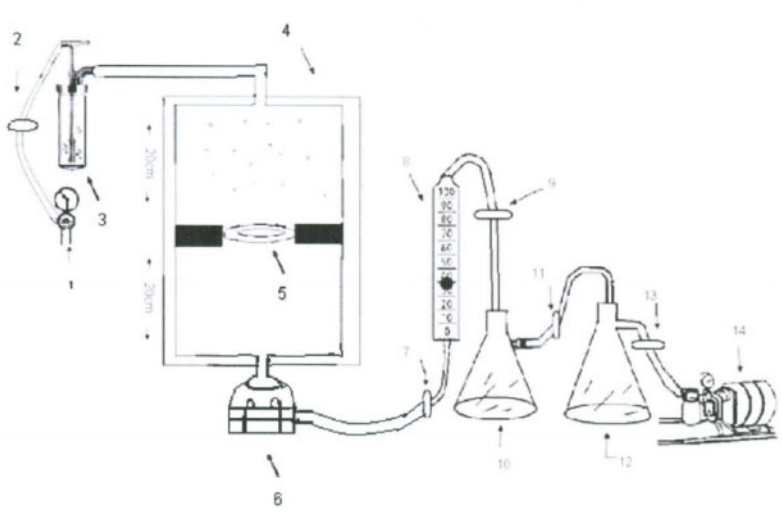


Aerosol challenge test: ASTM F2101

For the evaluation of the virus filtration efficiency of treated face mask materials against viruses

Method summary

- Based on ASTM Method F 2101.01 with modifications and customization to virus testing.
- Test mask mounted and sealed within a test chamber
- A nebulizer delivers an aerosol of the target virus inoculum to the upstream side of the mask
- A vacuum draws air through the mask
- A collection dish placed below the mask downstream collects aerosol droplets that pass through the mask sample
- The reduction in infectivity with and without mask is calculated as an indicator of effectiveness

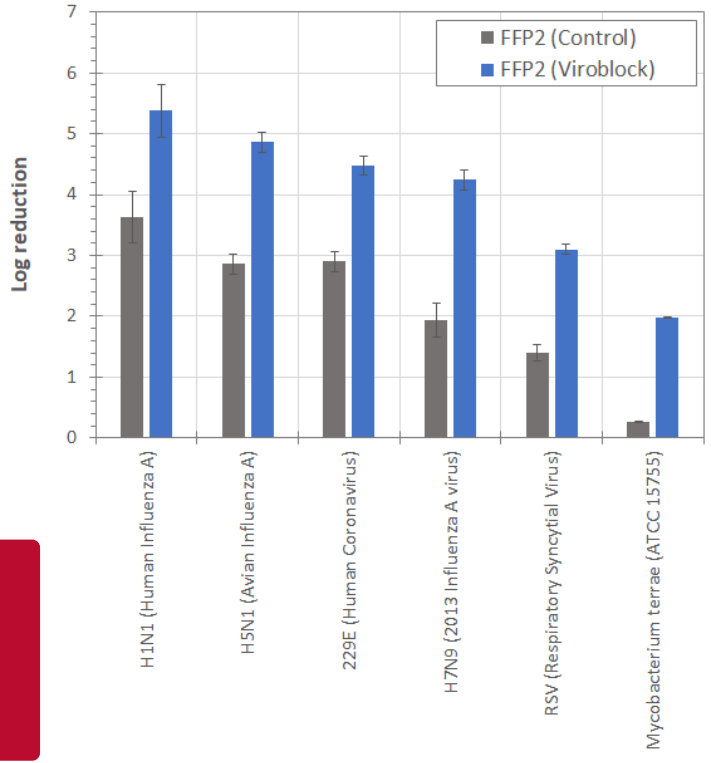


[1] ASTM F2101, Standard Test Method for Evaluating the Bacterial Filtration Efficiency (BFE) of Medical Face Mask Materials, Using a Biological Aerosol of Staphylococcus aureus, American Society for Testing Materials

Aerosol challenge test

FFP2 face masks (untreated control vs. HeiQ Viroblock treated)

		Log reduction			% reduction	
Study ID	Agent	Control	HeiQ Viroblock	Δ *	Control	HeiQ Viroblock
798-110	H1N1 (Human Influenza A)	3.63	**5.38**	**>50x**	99.9766%	99.9996%
798-111	H5N1 (Avian Influenza A)	2.86	**4.86**	**100x**	99.862%	99.999%
798-112	229E (Human Coronavirus)	2.90	**4.48**	**>30x**	99.874%	99.997%
798-114	H7N9 (2013 Influenza A)	1.93	**4.24**	**>200x**	98.825%	99.994%
798-115	RSV (Respiratory Syncytial Virus)	1.40	**3.10**	**>50x**	96.02%	99.92%
798-116	Mycobacterium terrae (ATCC 15755)	0.26	**1.98**	**>50x**	45.05%	98.95%



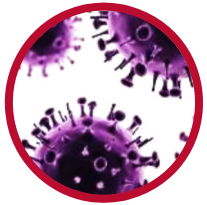
HeiQ Viroblock FFP2 masks* show **significantly (>10 times) improved reduction** in virus infectivity.

Effective against key virus types: H1N1, H5N1, H7N9, Coronavirus (229E), and RSV

* Delta improvement: Difference in log reduction of Δ = 1 indicates 10x; Δ = 2 indicates 100x

Misting spray contact test: AATCC 100

Testing for antiviral efficacy



Misting spray contact test: AATCC 100

For the evaluation of virucidal effectiveness of the treated fabric or mask material via direct contact with the test virus. It determines the potential of the treated test fabric or face mask to inactivate virus on direct contact

Method summary

- Based on AATCC Test Method 100 with customization for virus testing
- Spray mist of the target virus inoculum applied evenly onto the surface of the fabric (2 x 2 in. area) from a distance of 3 to 6 in
- Let sample stand for the contact time of interest
- Recover residues into a recovery medium (stomacher)
- Evaluate residual infectivity of recovered residues
- The reduction in infectivity compared to the starting inoculum is calculated as an indicator of effectiveness

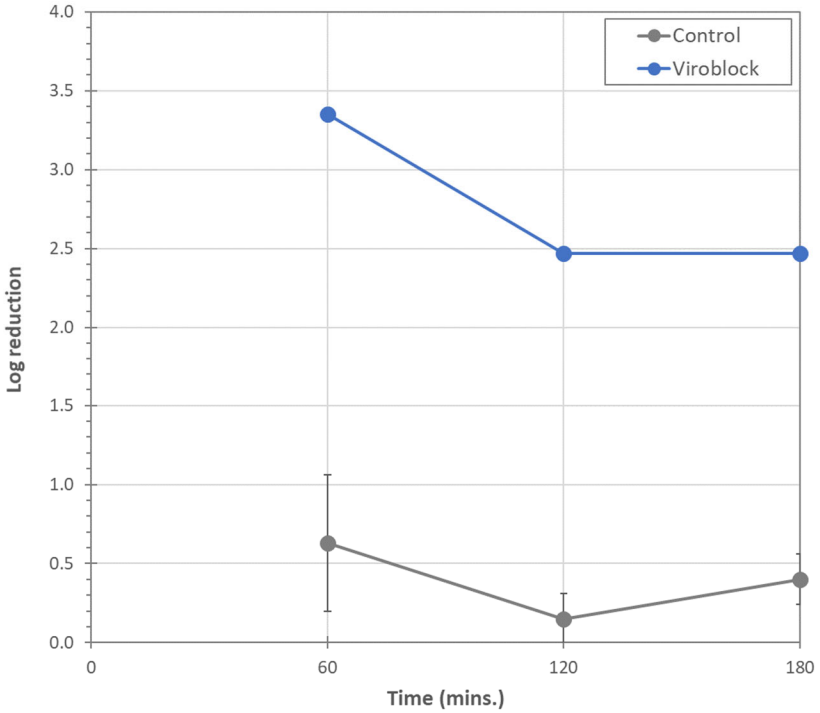
[2] AATCC Test Method 100, Antibacterial Finishes on Textile Materials: Assessment of", American Association of Textile Chemists and Colorists, AATCC Technical Manual (2019).

Misting study results

- Cotton fabric
  (Untreated control vs HeiQ Viroblock treated)
- Exposure to Human influenza A (H1N1)

			Log reduction	
Study	Agent	Time (mins)	**Control**	**HeiQ Viroblock**
798-119	H1N1 (Human Influenza A)	60	**0.63**	**3.35**
		120	**0.15**	**2.47**
		180	**0.40**	**2.47**

HeiQ Viroblock treated fabric shows **dramatically improved reduction (>100 times)** in virus infectivity over a 3 hour period



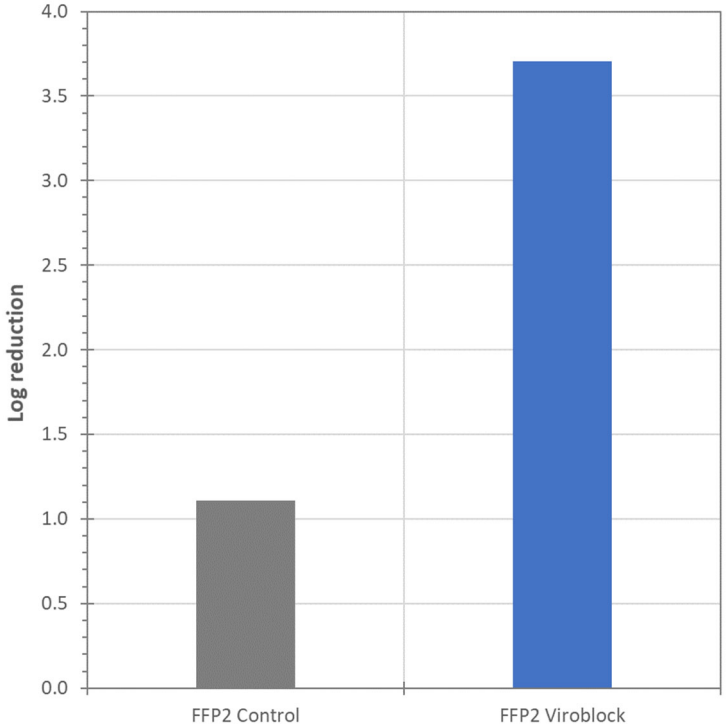
FFP2 control face mask vs. FFP2 HeiQ Viroblock treated

Misting study results

- FFP2 face masks
  (Untreated control vs HeiQ Viroblock treated)

		Log reduction			% reduction	
Study ID	Agent	Control	HeiQ Viroblock	Δ *	Control	HeiQ Viroblock
798-126	H1N1 (Human Influenza A)	1.11	3.71	>300x	92.2375%	99.9804%

HeiQ Viroblock treated FFP2 mask shows **significantly (>300 times) improved reduction in virus infectivity** (mist contact)



* Delta improvement: Difference in log reduction of Δ = 1 indicates 10x; Δ = 2 indicates 100x

Face mask performance comparison

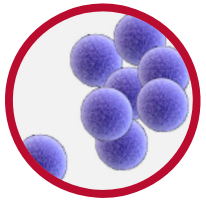
- FFP3 masks have a higher resistance to breathing than FFP2 masks leading to higher metabolic cost. Higher resistance can lead to greater fatigue and exertion for prolonged periods of mask wearing. [1, 2)]
- FFP2 mask material treated with HeiQ Viroblock showed similar virus reduction to FFP3 mask material [3)]
- Masks treated with HeiQ Viroblock provide significantly greater protection against surface contamination of the mask material [4)]

			Log reduction (H1N1 human influenza)			
			Aerosol protection [3]		Surface protection [4]	
Mask type	Metabolic cost (W/m2) [1]	Max breathing resistance (Pa) [2]	Control	HeiQ Viroblock	Control	HeiQ Viroblock
FFP2 (eqv. N95 / KN95)	20	70		5.22	1.11	3.71
FFP3 (eqv. N100/ NK100)	40	100	5.11			

[1] Roberge, R.J., Kim, J.H. and Coca, A., 2012. Protective facemask impact on human thermoregulation: an overview. Annals of occupational hygiene, 56(1), pp.102-112.
[2] Senić, Ž., Ilić, M., Radojković, A., Rajić, D. And Karkalić, R., Efficiency of Respiratory Protection Devices Against Bird Flu Virus. 4th International Conference on Defensive Technologies, OTEH 2011, 2011 Oct 6-7th.
[3] Viroblock, Aerosol study 798-121
[4] Viroblock, Misting study 798-126

Bacteriostatic efficacy test: ISO 20743

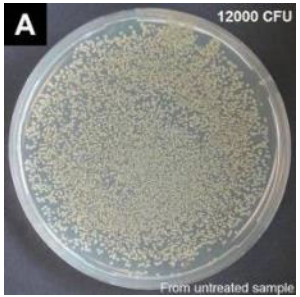
Testing for antibacterial efficacy



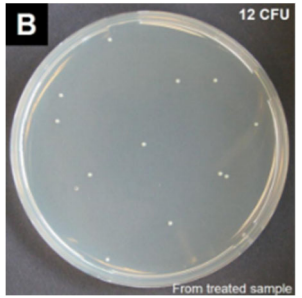
Bacteriostatic efficacy test (ISO 20743)

Quantitative test method for the determination of bacteriostatic activity on textiles including nonwovens

- This test method is applicable to all textile products including material for apparel, home textiles, cloth, wadding, thread etc.
- Widely accepted method for textile samples
- Specified organism:
  Staphylococcus aureus
  Klebsiella pneumoniae



Untreated

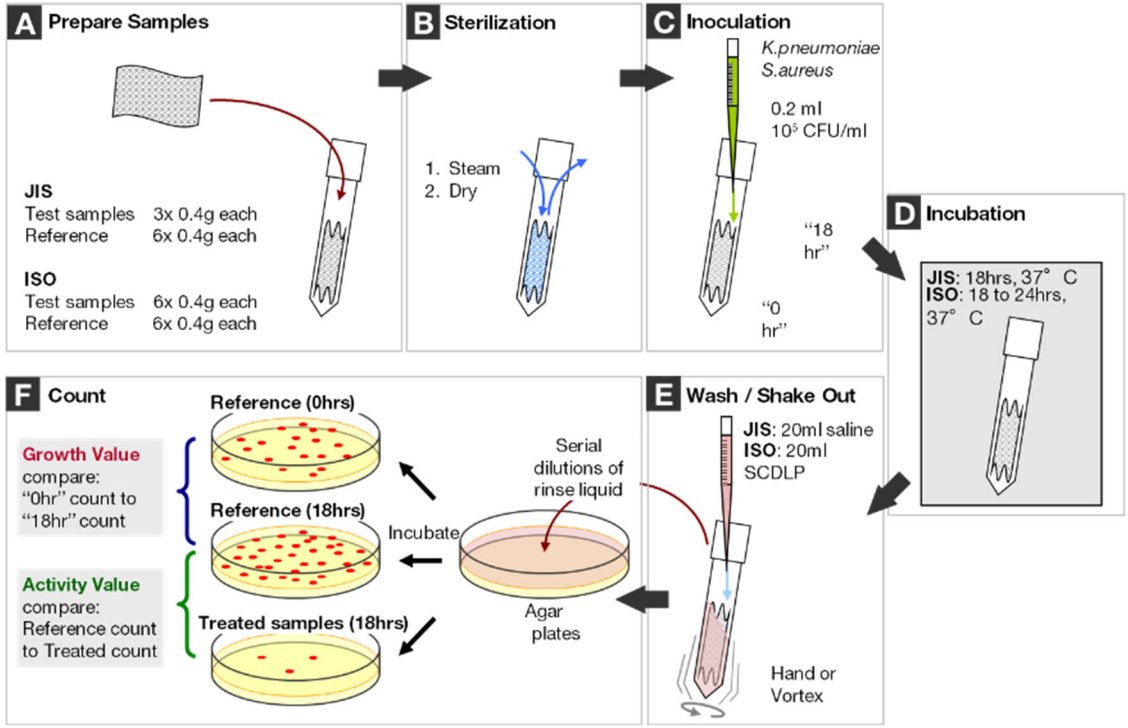


Treated with HeiQ Pure TAG

*QA = Quality Assurance test method (at cost if used for QC purpose)

[1] ISO 20743:2013, Textiles — Determination of antibacterial activity of textile products, International Organization for Standardization (ISO)

Testing Method – ISO 20743



[1] ISO 20743:2013, Textiles — Determination of antibacterial activity of textile products, International Organization for Standardization (ISO)

Where can HeiQ Viroblock be used?

HeiQ Viroblock application areas

All fiber types

HeiQ Viroblock NPJ03 is ideal for nonwoven products:

- Face masks
  - esp. Respirators like N95, FFP2 or equivalent
- Air filters
- Medical nonwovens (eg. surgical gowns, scrubs, drapes, curtains etc.)

Antimicrobial efficacy of HeiQ Viroblock NPJ03 lasts at least 30x washes (40 ℃/104 ℉ gentle washing).

HeiQ Viroblock makes the difference

HeiQ Viroblock's unique selling points

- HeiQ Viroblock treated textiles help to reduce the risk of viral and bacterial persistence on dry inanimate surfaces, thereby lowering the potential for transmission
- HeiQ Viroblock confers antiviral & antibacterial effect to textiles
- HeiQ Viroblock is a Swiss technology
- HeiQ Viroblock technologies effectiveness has been tried and tested as active against viruses that commonly affect human health

Every few years, epidemics breakout globally or regiionally causing disruption to lifes, sometimes leading to social distress, financial market crashes and economic downturn.

Photo: Commuters wearing protective masks in a MTR station in Hong Kong on the 5th day after first confirmed case of novel coronavirus (Covid-19) in Hong Kong.

Photo from CNBC, Paul Yeung | Bloomberg

HeiQ Viroblock Consumer Benefits

HeiQ Viroblock ingredient brand and hangtag

HeiQ Viroblock logo

SWISS TECH INSIDE logo
Sewn-in label

HeiQ Viroblock
hangtag

Requirements to use HeiQ Ingredient Brand elements:

- Fabric testing: The HeiQ treated fabric has to be tested **prior** to the hangtag application.
  A test report needs to be submitted for HeiQ's review.
  - Acceptable tests for HeiQ Pure treated fabrics: ISO 18184.
  - Third-party laboratory tests are accepted. HeiQ does not offer ISO 18184 test.
- Trademark license agreement: Use of the hangtags requires adherence to HeiQ's standard license agreement. Providing the brand company name and contact person is mandatory.
- Strict product label claim approval by HeiQ required (no direct or implied healthcare claims allowed!)

Regulatory coverage of HeiQ Viroblock

Human patch test results

Farcoderm
TESTED WELLNESS

in collaboration with:
University of Pavia
Prof. FULVIO MARZATICO
Laboratory of Pharmacobiochemistry
Pharmacology and Toxicology Division

REPORT ON A HUMAN PATCH TEST

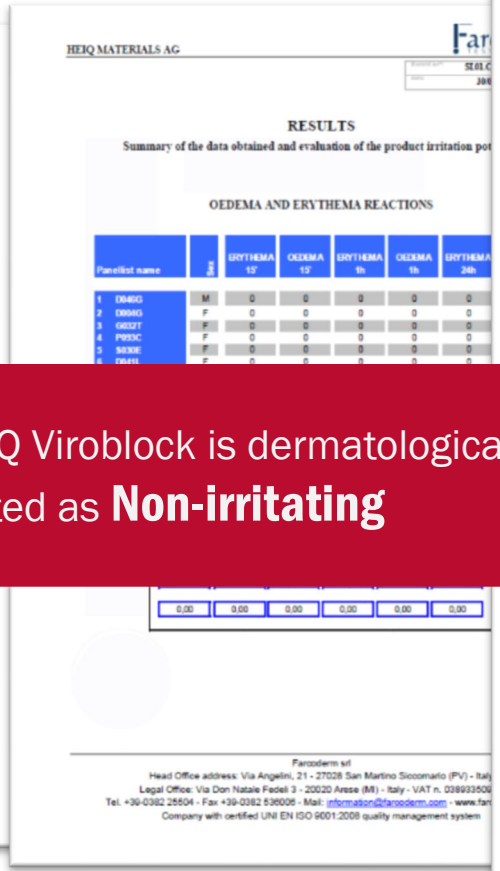
48 hour closed patch test under occlusion

Skin test to evaluate potential skin irritation after contact with a non-woven fabric

HEIQ MATERIALS AG

FABRIC SAMPLE "8"

Farcoderm srl
Head Office address: Via Angelini, 21 - 27028 San Martino Siccomario (PV) - Italy
Legal Office: Via Don Natale Fedeli 3 - 20020 Arese (MI) - Italy - VAT n. 03893350961
Tel. +39-0382 25504 - Fax +39-0382 536006 - Mail: information@farcoderm.com - www.farcoderm.com
Company with certified UNI EN ISO 9001:2008 quality management system



HEIQ MATERIALS AG

RESULTS

Summary of the data obtained and evaluation of the product irritation pot

OEDEMA AND ERYTHEMA REACTIONS

Panellist name	Sex	ERYTHEMA 15'	OEDEMA 15'	ERYTHEMA th	OEDEMA th	ERYTHEMA 24h
1 D04IG	M	0	0	0	0	0
2 D06IG	F	0	0	0	0	0
3 G032T	F	0	0	0	0	0
4 P093C	F	0	0	0	0	0
5 S030E	F	0	0	0	0	0
6 D041I	F	0	0	0	0	0
		0,00	0,00	0,00	0,00	0,00

Farcoderm srl
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Company with certified UNI EN ISO 9001:2008 quality management system

HEIQ MATERIALS AG

Farcoderm
TESTED WELLNESS

SI.01.C_2011/1778
30/09/2011

CONCLUSIONS

The table and the graphs listed above contain the values of the erythema and oedema indices recorded for each of the 10 volunteers. Potential skin irritation of the product has been assessed according to the amended Draize classification.

On the basis of the data obtained we deem the non woven fabric:

HEIQ MATERIALS AG

FABRIC SAMPLE"8"

NON IRRITATING

"DERMATOLOGICALLY TESTED"

...no Siccomario – 30th September 2011

Experimenter
Dr. Enza Cestone

Quality control
Dr. Carmen Palumbo

Scientific supervisor
Prof. Fulvio Marzatico

Page 10 out of 11

Farcoderm srl
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Company with certified UNI EN ISO 9001:2008 quality management system

HeiQ Viroblock is dermatologically tested as **Non-irritating**

Regulations & labels

HeiQ Viroblock NPJ03 is thoroughly tested for Safety, Sustainability and Environment

- Harmless to skin and body
- Uses a minimum of active ingredient

The HeiQ Viroblock NPJ03 product is US EPA registered and EU REACH compliant. *Check with HeiQ for your target market!*

The commercialization of the HeiQ Viroblock NPJ03 treated article might be subject to further local registrations. Consult HeiQ for Labelling Requirements and Permitted Claims on HeiQ Viroblock NPJ03 Treated Articles!

bluesign® approved

OEKO-TEX® CONFIDENCE IN TEXTILES STANDARD 100

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Ø ZDHC

Zero Discharge of Hazardous Chemicals

Oekotex, Bluesign, ZDHC: pending for approval

For **antimicrobial & odor control** on textiles, please take a look at our **HeiQ Pure** products:

HEIQ PURE

Differentiate.
Innovate.

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SWISS TECH INSIDE

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Appendix

Textiles: a vector for viruses and bacteria

- Textiles from clothing, gowns, drapes and sheets provide an ideal surface for contamination with viruses and bacteria. Contaminated textiles can act as a surface for transmitting pathogens [1, 2, 3)]
- Antiviral and antibacterial textiles can play a part in an overall strategy to address transmission of bacteria and viruses in sensitive environments
- Preventing bacteria and viruses from contaminating textiles can play a role in minimizing opportunities for transmission [4)]
- Textiles treated with HeiQ Viroblock are designed to reduce virus and bacteria contamination of textile fabrics in sensitive environments

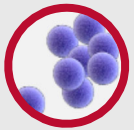
1) A.Kramer, I.Schwebke, G.Kampf (2006) "How long do nosocomial pathogens persist on inanimate surfaces? A systematic review", BMC Infectious Diseases, 6(130).
2) A.Neely & M.Maley (2000) "Survival of Enterococci and Staphylococci on Hospital Fabrics and Plastic", Journal of Clinical Microbiology, 38, p.724–726.
3) RW.Sidwell, GJ.Dixon, E.McNeil (1966) "Quantitative Studies on Fabrics as Disseminators of Viruses. I. Persistence of Vaccinia Virus on Cotton and Wool Fabrics", Applied Microbiology, 14(1), p.55-59.
4) D.Höfer “The Role of Textiles in Chains of Infection”, AMH Magazine, (April 2010).

Protection against viruses and bacteria

- HeiQ Viroblock provides textiles with effective protection against contamination and transmission of viruses and bacteria
- HeiQ Viroblock NPJ03 has been tested effective against several types of viruses and bacteria, for example:

HeiQ Viroblock NPJ03 tested effective against **Coronavirus** (229E)

Virus examples (enveloped type):	Bacteria examples:
▪ Coronavirus (229E, human coronavirus)[1)] ▪ H1N1 (Human Influenza A) ▪ H5N1 (Avian Influenza A) ▪ H7N9 (2013 Influenza A virus) ▪ RSV (Respiratory Syncytial Virus) ▪ Sendai	▪ Staphylococcus aureus ▪ Klebsiella pneumoniae ▪ Mycobacterium terrae (ATCC 15755)



1) The membrane of all coronaviruses (229E, SARS-CoV, SARS-CoV-2) is very similar and destroyed by the same mode of action of HeiQ Viroblock NPJ03 (Yanni Li et. al. (2020) “Similarities and Evolutionary Relationships of COVID-19 and Related Viruses”)

Silver antiviral effect - literature

#	Study	Silver form	Viruses tested	Finding
1	De Gusseme et.al. (2010)	AgNP lactobacillus matrix	murine norovirus 1 (MNV)	Silver (via silver ions and/or silver metal) provides antiviral action non-enveloped virus MNV
2	Rogers et.al. (2008)	AgNP and $AgNO_3$	Monkeypox virus (MPV)	Ag ions and AgNPs antiviral effectiveness. Possible blockade of host cell binding, disruption of host cell biochemical pathways, or both
3	Lv et.al. (2014)	AgNP, Ag colloids, Ag nanowires	Transmissible gastroenteritis virus (TGEV)	Effective viricidal activity. Inhibit viral entry.
4	Fayaz et.al (2012)	AgNP coating on polyurethane	HIV-1 & HSV	Silver ions interact with virus membrane moieties
5	Galdiero et.al. (2011) - review	AgNP and AuNP	HIV-1, HSV-1, RSV, MPV, Influenza, TCRV, HBV	NPs interact with surface glycoproteins and viral genome
6	Lara et.al. (2010)	AgNP	HIV-1	Inhibits binding, fusion and infectivity. NP binding to glycoprotein
7	Kheiri et.al. (2009)	AgNP	H1N1	Degradation of virus membrane
8	Lu etl.al. (2008)	AgNP	Hepatitus B (HBV)	Inhibition of HBV production. Interaction of AgNP with DNA
9	Pedersen et.al. (2008)	AgNP (ASAP-AGX-32)	Avian influenza (H5N1)	Inhibitive effect on Infuenza in mice
10	Sun et.al. (2005)	AgNP	HIV-1	Inhibition of HIV replication
11	Elechiguerra et.al. (2005)	AgNP, 1 to 10nm	HIV-1	AgNP binding to glycoproteins

[1] De Gusseme, B. et.al., 2010. Biogenic silver for disinfection of water contaminated with viruses. Appl. Environ. Microbiol., 76(4), pp.1082-1087.
[2] Rogers, J.V. et.al., 2008. A preliminary assessment of silver nanoparticle inhibition of monkeypox virus plaque formation. Nanoscale Research Letters, 3(4), pp.129-133.
[3] Lv, X., et.al. 2014. Inhibitory effect of silver nanomaterials on transmissible virus-induced host cell infections. *Biomaterials*, *35*(13), pp.4195-4203.
[4] Fayaz, A.M., et.al., 2012. Inactivation of microbial infectiousness by silver nanoparticles-coated condom: a new approach to inhibit HIV-and HSV-transmitted infection. International journal of nanomedicine, 7, p.5007.
[5] Galdiero, S. et.al.., 2011. Silver nanoparticles as potential antiviral agents. Molecules, 16(10), pp.8894-8918.
[6] Lara, H.H. et.al. 2010. Mode of antiviral action of silver nanoparticles against HIV-1. Journal of nanobiotechnology, 8(1), p.1.
[7] Kheiri. et.al., 2009, In Vitro Antiviral Effect of "Nanosilver" on Influenza Virus, DARU 2009 17 (2) 88-93.
[8] Lu, L. et.al. 2008. Silver nanoparticles inhibit hepatitis B virus replication. Antiviral therapy, 13(2), p.253.
[9] Pedersen, G. et.al. 2008., Effect of Prophylactic Treatment with ASAP-AGX-32 and ASAP Solutions on an Avian Influenza A (H5N1) Virus Infection in Mice. RET, 775, pp.852-8964.
[10] Sun, R.W.Y et.al., 2005. Silver nanoparticles fabricated in Hepes buffer exhibit cytoprotective activities toward HIV-1 infected cells. Chemical communications, (40), pp.5059-5061.
[11] Elechiguerra, J.L. et.al., 2005. Interaction of silver nanoparticles with HIV-1. Journal of nanobiotechnology, 3(1), p.6.

Outline of antiviral testing

1. Aerosol challenge tests
2. Misting spray contact tests

HeiQ Viroblock test results: Aerosol challenge study

Study ID	Short title	Report date	Test method	Articles	Agent	Test articles	Reduction	95% CI
798-108	Aerosol testing FFP2 vs SM prototype	20/03/2013	Aerosol challenge test	Face mask	H1N1 (Human Influenza A)	VB-FFP2	**4.33**	0.27
						VB-FFP2-Control	**2.73**	0.16
						VB-SM	**3.90**	0.16
						VB-SM-Control	**1.34**	0.28
798-110	Aerosol testing aerosol FFP2 vs FFP3	29/05/2013	Aerosol challenge test	Face mask	H1N1 (Human Influenza A)	FFP2	**5.38**	0.43
						FFP2 CTL	**3.63**	0.43
						FFP3	**3.73**	0.28
						FFP3 CTL	**1.73**	0.28
798-111	Aerosol Avian Flu	4/06/2013	Aerosol challenge test	Face mask	H5N1 (Avian Influenza A)	FFP2	**4.86**	0.16
						FFP2 CTL	**2.86**	0.16
798-112	Aerosol human coronavirus	13/06/2013	Aerosol challenge test	Face mask	ATCC VR-740 (Human Coronavirus)	FFP2	**4.48**	0.16
						FFP2 CTL	**2.90**	0.16
798-114	Aerosol testing H7N9	19/07/2013	Aerosol challenge test	Face mask	H7N9 (2013 Influenza A virus)	FFP2	**4.24**	0.16
						FFP2 CTL	**1.93**	0.28
798-115	Aerosol testing RSV	28/08/2013	Aerosol challenge test	Face mask	RSV (Respiratory Syncytial Virus)	FFP2	**3.10**	0.08
						FFP2 CTL	**1.40**	0.14
798-116	Aerosol M.terrae	29/11/2013	Aerosol challenge test	Face mask	Mycobacterium terrae (ATCC 15755)	FFP2	**1.98**	0.00
						FFP2 CTL	**0.26**	0.01
798-117	Aerosol testing VBSM003	25/03/2014	Aerosol challenge test	Face mask	H1N1 (Human Influenza A)	Facemate classic (VB)	**4.19**	0.02
						Facemate classic (C)	**2.39**	0.43
798-120	Aerosol FFP2 benchmark	31/07/2014	Aerosol challenge test	Face mask	H1N1 (Human Influenza A)	Vflex 9105	**2.15**	0.25
						PFRP2-62408	**1.95**	0.14
						FFP2 NR-VR202	**2.30**	0.38
						FFP2D NR-VBHF002	**3.55**	0.38
						Control mask	**1.90**	0.25
798-121	Aerosol old vs FFP2	26/11/2014	Aerosol challenge test	Face mask	H1N1 (Human Influenza A)	FFP2 NRD-VBHF002 (old version)	**5.22**	0.00
						FFP2 NRD-VBHF002 (new version)	**5.22**	0.00
						FFP3 NRD 3M (reference mask)	**5.11**	0.11
798-122	Aerosol 2P vs 2S	18/02/2015	Aerosol challenge test	Face mask	H1N1 (Human Influenza A)	VBHF002P	**4.47**	0.27
						VBHF002S	**4.96**	0.30
798-125	Aerosol testing 3P vs Valmy FFP3	17/07/2015	Aerosol challenge test	Face mask	H1N1 (Human Influenza A)	Viroblock 3P FFP3 Mask	**3.57**	0.29
						Valmy FFP3 Mask	**2.54**	0.46

Selected data shown in following slides

HeiQ Viroblock test results: Misting contact study

Study ID	Short title	Report date	Test method	Articles	Agent	Test articles	Time (mins.)	**Reduction**	95% CI
798-118	Cotton H1N1 contact kill	27/03/2014	Misting spray test	Cotton fabric	H1N1 (Human Influenza A)	Cotton fabric (T)	10	**1.59**	0.33
							30	**1.89**	0.16
							60	**3.12**	0.31
						Cotton fabric (C)	10	**2.04**	0.33
							30	**2.31**	0.13
							60	**2.16**	0.00
798-119	Cotton H1N1 contact kill bis	29/04/2014	Misting spray test	Cotton fabric	H1N1 (Human Influenza A)	Cotton fabric (T)	60	**3.35**	0.00
							120	**2.47**	0.00
							180	**2.47**	0.00
						Cotton fabric (C)	60	**0.63**	0.43
							120	**0.15**	0.16
							180	**0.40**	0.16
798-123	Virus contact kill softner	29/04/2015	Misting spray test	Cotton fabric	H1N1 (Human Influenza A)	White Cotton #1	10	**2.13**	0.98
							30	**2.04**	0.24
							60	**1.79**	0.25
						White Cotton #2	10	**2.21**	0.49
							30	**2.64**	0.00
							60	**2.64**	0.00
						White Cotton #3	10	**1.89**	0.00
							30	**2.79**	0.25
							60	**2.54**	0.24
						White Cotton #4	10	**2.29**	0.25
							30	**3.14**	0.00
							60	**3.04**	0.24
						White Cotton #5	10	**3.39**	0.00
							30	**3.77**	0.29
							60	**3.39**	0.00
798-124	Bacteria contact kill	9/07/2015	Misting spray test	Cotton fabric	Staphylococcus aureus (ATCC 6538)	White Cotton #1	30	**1.07**	
							60	**1.26**	
							120	**1.22**	
						White Cotton #4	30	**1.07**	
							60	**1.26**	
							120	**1.22**	
						White Cotton #5	30	**-0.08**	
							60	**0.53**	
							120	**0.38**	
798-126	Contact kill 4 FFP2 mask batches non GLP	24/11/2015	Misting spray test	Respirators	H1N1 (Human Influenza A)	FFP2 Respirator (Lot 31001)		**4.18**	
						FFP2 Respirator (Lot 31005)		**3.61**	
						FFP2 Respirator (Lot 31009)		**3.43**	
						FFP2 Respirator (Lot 31016)		**3.61**	
						FFP2 Respirator (Control fabric)		**1.11**	

Selected data shown in following slides