TiO_2 Photocatalyst

GAEA CLEAN

Guide to
Multifunctional Hygiene Textile Finish
with durable effect

In order to kill 99.99% of viruses and bacteria, and decompose odorous substances

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Introduction (1)—Outline of TiO2 photocatalyst

Japan has been leading the TiO_2 photocatalyst market since the discovery that titanium dioxide photocatalyzed the decomposition of water was announced in 1972 in the journal Nature by Prof. Akira Fujiyama and Kenichi Honda, and is now called the Honda-Fujishima effect after its discoverers.

Photocatalyst has been used in products of various fields depending on the effect.

Prof. Akira Fujishima (1942 -)

Prof. Kenichi Honda (1925 – 2011)

A photocatalyst is any material that uses light energy to promote a chemical reaction. There are various materials that show photocatalytic capability, and titanium dioxide (TiO_2) is said to be the most effective.

TiO_2 is usually a white powder that is widely used as an ingredient of white pigment, white plastic and white paper. It is also used for cosmetic products since it absorbs ultraviolet (UV) light.

TiO_2 photocatalyst is devised by slightly changing its crystal structure and converting it to fine powder in order to increase its photocatalytic capability.

TiO_2 shows "decomposition power" and "hydrophilic property" upon exposure to UV light.

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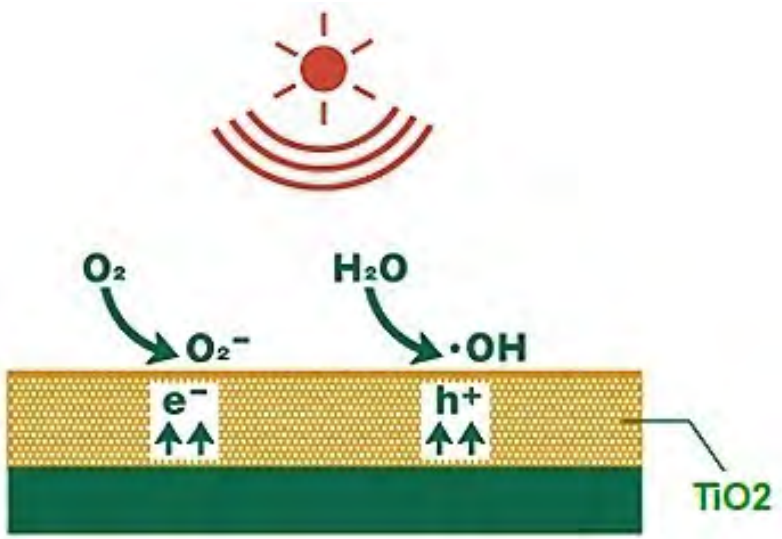
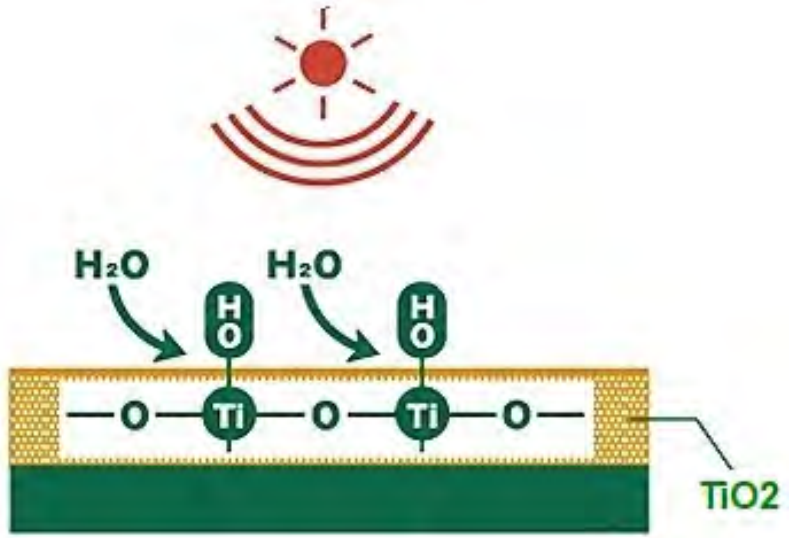
Introduction (2)—TiO_2 photocatalyst performance



Decomposition power:
When exposed to UV light, TiO_2 produces electrons (e^-) and holes (h^+). These react with oxygen and water (O_2, H_2O) in the air and produce activated oxygen (O_2, OH), which decomposes various organic substances on the surface.



Hydrophilic property:
When TiO_2 is exposed to UV light, the titanium (Ti) reacts with water (H_2O) in the air, producing a hydrophilic group (-OH) layer that blends with water on the surface.

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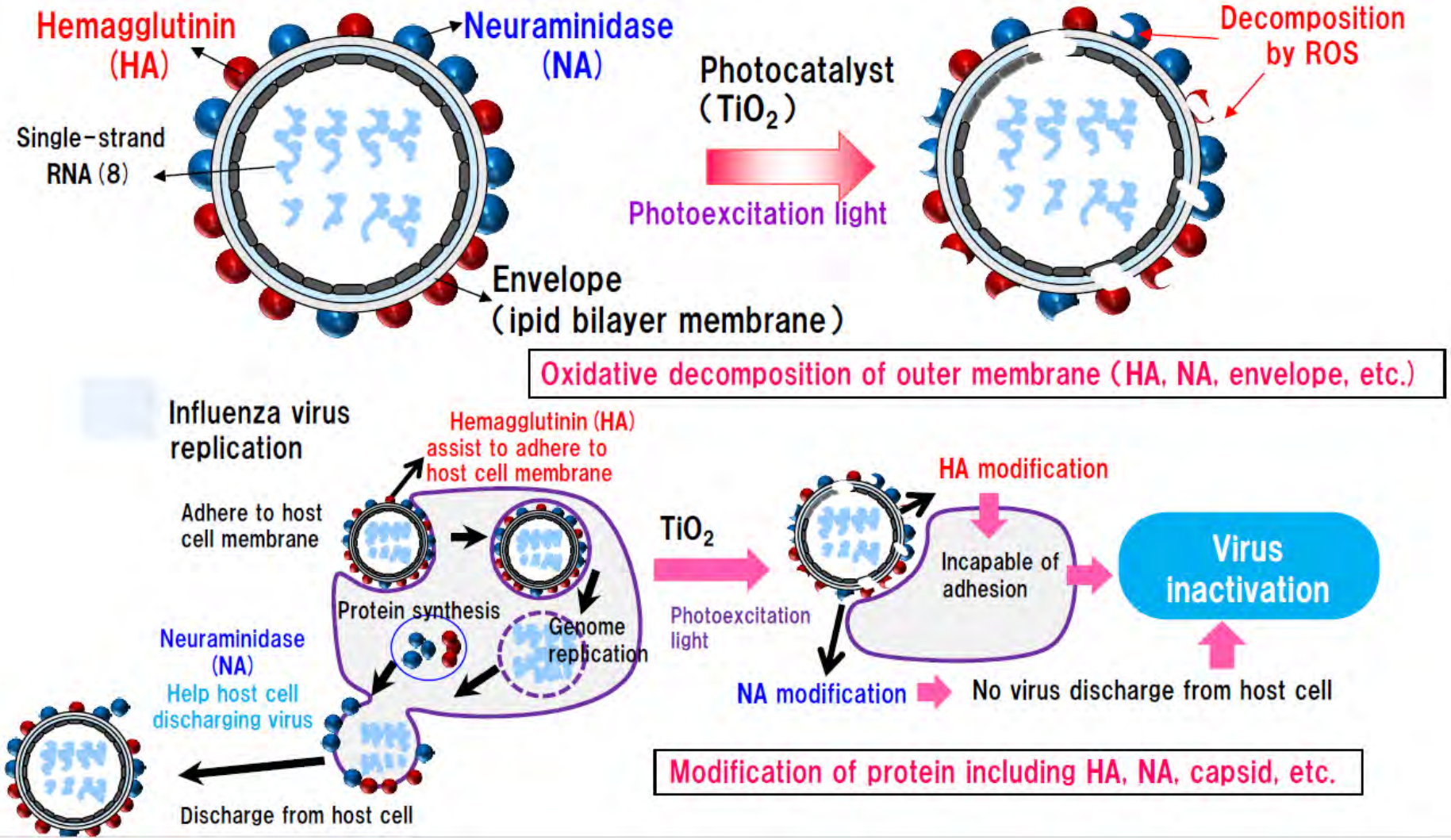
Introduction (3)—Mechanism of antivirus performance

Photocatalytic activity involves the generation of reactive oxygen species (ROS) that can decompose viral outer membrane (envelope or capsid) and inhibit virus activity (infectivity).



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About GAEA CLEAN (1)—Basic information

GAEA CLEAN is a special white-colored solution applied for textile via pad-dry process. The solution is composed of nano-sized particles of apatite-coated titanium dioxide and special binder.

GAEA CLEAN treated cloth offers photocatalytic activity with UV radiation (10 – 400nm) from sunlight and fluorescent lamp that decomposes organic substances.

Physical & Chemical properties

Appearance	**: White liquid**
pH	**: 6.5 – 8.5**
Specific gravity	**: 1.1 (25℃)**
Viscosity	**: 40 – 60 mPa・s (25℃)**
Boiling point	**: about 100℃**
Solubility	**: Insoluble in water & alcohol**

Precautions

- **Stir the solution before use (if the solution has sediment).**
- **Do not use the solution if the color was changed from the original white color.**
- **Simple water quality check is carried out: add 20-time diluted solution to water in a bottle and leave it for 3 hours. If the solution was coagulated, water has to be treated to be soft water.**
- **Do not use it together with cationic auxiliaries.**
- **Fabric to be treated has to be in dry state.**
- **Fabric to be treated has to be water-absorbent.**
- **Clean up cisterns of the machine in order to remove residual particles.**
- **Avoid to use centrifugal dehydration machine for treated cloth.**

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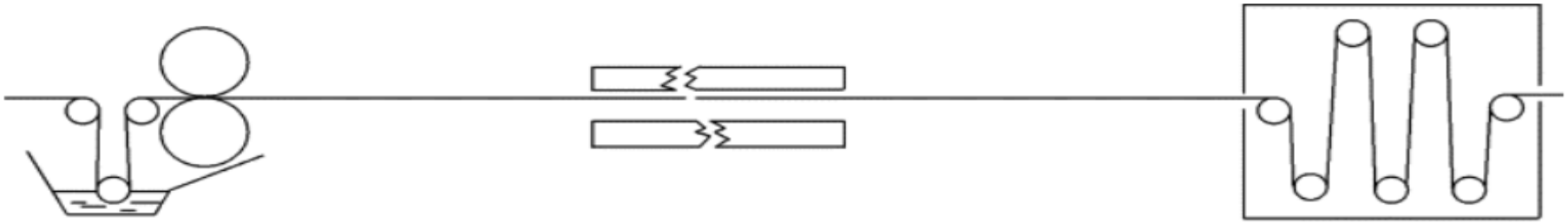
About GAEA CLEAN (2)—Method of application

GAEA CLEAN is applied to textile via pad-dry-cure process:



Padding **Drying at 110˚C for 2 – 3 min.** **Curing 150 - 160˚C for 1 min.**

Standard padding solution:

GAEA CLEAN 2.5%

COSMO FIXER 150 ECO* 0.7 – 0.8%

100% pickup

*** Isocyanate type cross linking agent that may be optionally added if it is desired to improve more durability and washability.**

Variation of padding solution

Substrate	Pickup (%)	Ideal concentration (%)
100% cotton	100	2.5
	70	3.6
	65	3.9
Cotton/Synthetic blend	60	4.2
	55	4.6
100% wool or its blend	50	5.0
	45	5.6

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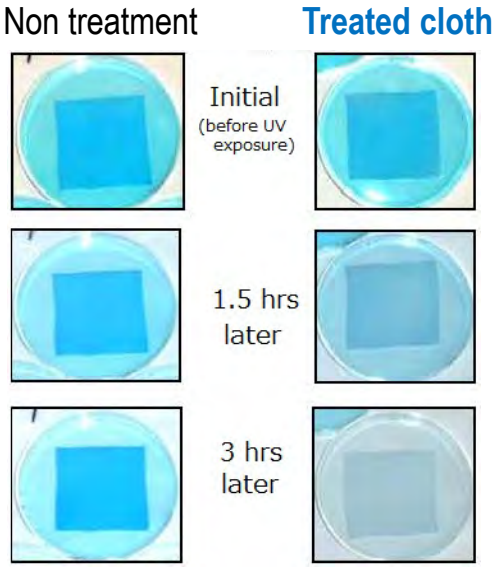
Quality check (1)—Coloring tests

Quality check after treatment is one of important procedures in order to secure satisfactory photocatalytic reaction.

Methylene blue test

Photocatalytic reaction can be visibly seen by dipping treated cloth in methylene blue solution and exposing to UV radiation.

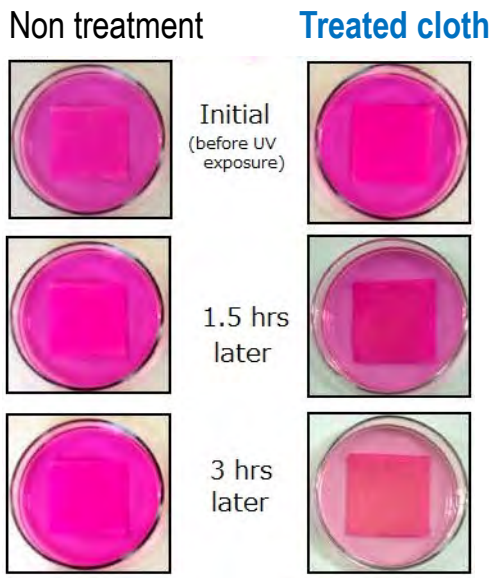
Note) the result may be affected by color deposit into fiber.



Rhodamine test

Photocatalytic reaction can be visibly seen by dipping treated cloth in rhodamine solution and exposing to UV radiation.

Note) the result is more reliable than methylene blue test.

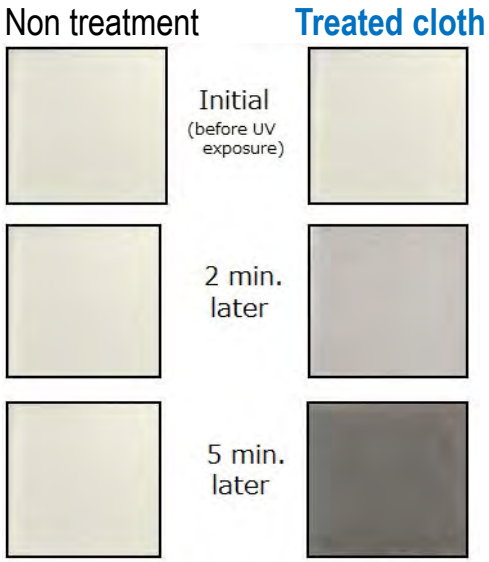


Silver nitrate test (see the following page)

Degree and distribution of can be visibly seen by dipping treated cloth in AgNO3 solution and exposing to UV radiation.

The color is changed in black or brown.

Note) the method is applicable for white or pale color cloth.



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Quality check (2) – how to make $AgNO_3$ reagent

The following shows how to make Silver nitrate ($AgNO_3$) reagent for the quality check.

Condition

Volume of reagent : 100 ml
Density : 1g/100ml

Procedures

- **Place a 100ml-capacity beaker on the scale with accuracy of 0.1g.**
- **Minus the tare.**
- **Weigh 1g silver nitrate on the scale (use a plastic spoon because a metal spoon might be plated).**
- **Pour 99 ml purified water into the beaker as stirring.**

Silver nitrate test

Degree and distribution of TiO2 can be visibly seen by dipping treated cloth in AgNO3 reagent and exposing to UV radiation for 5 minutes. The color is changed in black or brown.
Note) the method is applicable for white or pale color cloth.

Test Condition

Size of sample : any size is OK
UV lamp : Black light fluorescent lamp 40W FL40S x 3 in parallel
UV light strength : about 5mW/cm^2
Pretreatment : sample shall be preliminary exposed to the above UV light for 8 hours.
Exposure time : 5 min.

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Quality check (2)—Simple smoke odor test

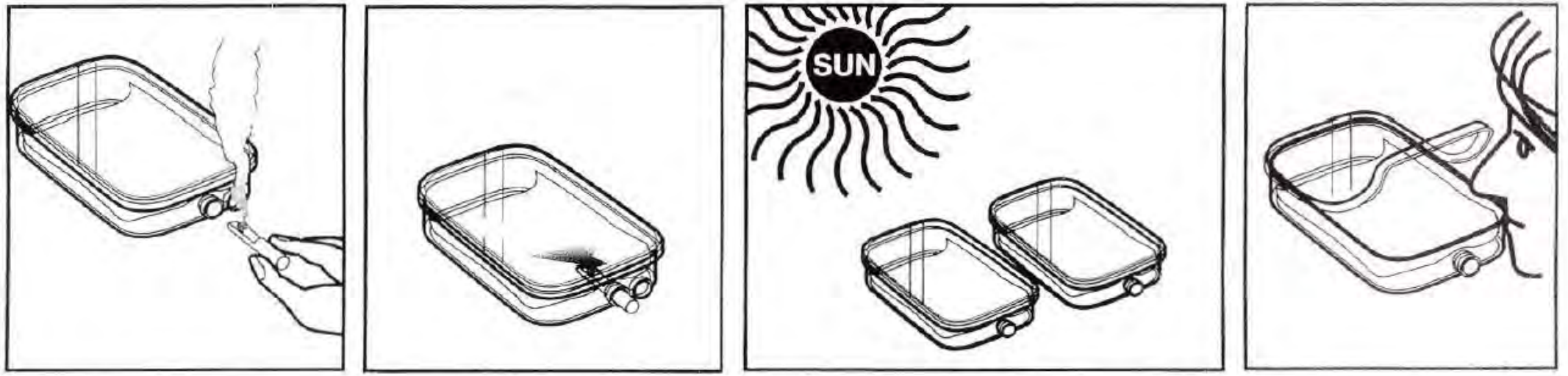
Demonstration kit for GAEA CLEAN treated cloth (with tobacco odor smell)

1. Prepare cigarette smoke and two plastic demonstration kits. Place treated cloth and non-treated cloth into each box.

2. Insert cigarette smoke into the boxed for 5 seconds.

3. Seal the boxes and let them expose to sunlight for 6 to 7 hours.

4. Compare residual smell inside the boxes.



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Test data (1)—Antibacterial property to S. aureus

To Staphylococcus aureus

Staphylococcus aureus (ATCC 6538P)					
The number of inoculated bacteria [A]				2.6×10^4	Log A 4.4
The number of inoculated bacteria in control* after inoculation [B] (in dark place)				1.3×10^7	Log B 7.1
The number of inoculated bacteria in control* after inoculation [C] (exposure to black light fluorescent lamp for 5 hours)				3.2×10^4	Log C 4.5
*Control : 100% cotton fabric 50 mm x 50 mm					
GAEA CLEAN treated cloth	The number of bacteria in the sample after inoculation [D]		Log D	Antibacterial activity Log A – log D	Bacteriostatic activity Log B – log D
	HL-0	4.0 x 10	1.6	**2.8** (Criteria : > 0)	**5.5** (Criteria : ≥ 2.2)
	HL-50	6.0 x 10	1.6	**2.6** (Criteria : > 0)	**5.3** (Criteria : ≥ 2.2)

The test was conducted by BOKEN Quality Evaluation Institute in 2004 based on GAEA ORIGINAL METHOD (before establishment of JIS R1702 or ISO27447).

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Test data (2)—Antibacterial property to K. pneumoniae

To Klebsiella pneumoniae

Klebsiella pneumoniae (ATCC 4352)				
The number of inoculated bacteria [A]			2.1×10^4	Log A 4.3
The number of inoculated bacteria in control* after inoculation [B] (in dark place)			2.7×10^7	Log B 7.4
The number of inoculated bacteria in control* after inoculation [C] (exposure to black light fluorescent lamp for 5 hours)			2.0×10^7	Log C 7.3
*Control : 100% cotton fabric 50 mm x 50 mm				
GAEA CLEAN treated cloth	The number of bacteria in the sample after inoculation [D]	Log D	Antibacterial activity Log A – log D	Bacteriostatic activity Log B – log D
	< 20	1.3	**3.0** (Criteria : > 0)	**6.1** (Criteria : ≥ 2.2)

The test was conducted by BOKEN Quality Evaluation Institute in 2004 based on GAEA ORIGINAL METHOD (before establishment of JIS R1702 or ISO27447).

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Test data (3)—Antibacterial property to E. coli

To Escherichia coli

Escherichia coli (NBRC 3301)				
The number of inoculated bacteria [A]			2.3×10^4	Log A 4.4
The number of inoculated bacteria in control* after inoculation [B] (in dark place)			2.8×10^7	Log B 7.4
The number of inoculated bacteria in control* after inoculation [C] (exposure to black light fluorescent lamp for 5 hours)			2.1×10^7	Log C 7.3
*Control : 100% cotton fabric 50 mm x 50 mm				
GAEA CLEAN treated cloth	The number of bacteria in the sample after inoculation [D]	Log D	Antibacterial activity Log A – log D	Bacteriostatic activity Log B – log D
	< 20	1.3	**3.1** (Criteria : > 0)	**6.1** (Criteria : ≥ 2.2)

The test was conducted by BOKEN Quality Evaluation Institute in 2004 based on GAEA ORIGINAL METHOD (before establishment of JIS R1702 or ISO27447).

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Test data (4)—Antibacterial property to MRSA

To MRSA

MRSA– methicillin resistant staphylococcus aureus (IID 1677)					
The number of inoculated bacteria [A]				2.6 x 10^4	Log A 4.4
The number of inoculated bacteria in control* after inoculation [B] (in dark place)				1.3 x 10^7	Log B 7.1
The number of inoculated bacteria in control* after inoculation [C] (exposure to black light fluorescent lamp for 5 hours)				1.8 x 10^4	Log C 4.3
*Control : 100% cotton fabric 50 mm x 50 mm					
GAEA CLEAN treated cloth	The number of bacteria in the sample after inoculation [D]		Log D	Antibacterial activity Log A – log D	Bacteriostatic activity Log B – log D
	HL-0	< 20	1.3	**3.1** (Criteria : > 0)	**5.8** (Criteria : ≥ 2.2)
	HL-50	< 20	1.3	**3.1** (Criteria : > 0)	**5.8** (Criteria : ≥ 2.2)

The test was conducted by BOKEN Quality Evaluation Institute in 2004 based on GAEA ORIGINAL METHOD (before establishment of JIS R1702 or ISO27447).

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Test data (5)—Odor killing property to ammonia/acetaldehyde

To Ammonia / Acetaldehyde

Sample 10 cm x 10 cm	Ammonia (3 liters)			Acetaldehyde (3 liters)		
	Initial (ppm)	24 hours later (ppm)	Reduction rate* (%)	Initial (ppm)	24 hours later (ppm)	Reduction rate* (%)
GAEA CLEAN treated cloth	100	1 or less	**98.9 or more**	14	1 or less	**92.9 or more**
Non treatment Blank		62	28.7		14	0
Control**		86	--		14	--

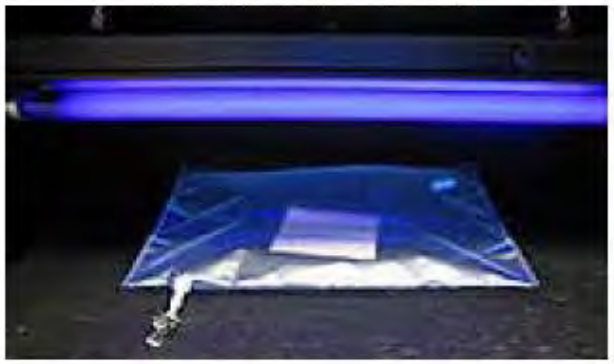
The test was conducted by Kaken Test Center in accordance with gas bag B method.

Light source : Black light fluorescent lamp (40W FL40S/BLB or its equivalent)
UV strength & time : 1 mW/m^2 24 hours
Pretreatment : Samples were exposed to UV rays with strength of 4 mW/m^2 for 5 hours.

$$\text{* Reduction rate} = \frac{\text{Control 24 hours later} - \text{Sample 24 hours later}}{\text{Control 24 hours later}} \times 100$$

** Control : bag under the same procedure without sample

[Gas Bag B method]



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Test data (6)—Odor killing property to ammonia (visible)

To Ammonia (visible data)

Test conditions: 18 ml aqueous solution containing 10 ppm ammonia and 2 – 3 drops of Phenolphtalein that makes ammonia visible red color.
Sample: 100% polyester in size of 3.5 x 3.5 cm; Glass Bottle volume: 20ml
(Untreated fabric in the left bottle, **GAEA CLEAN treated cloth** in the right bottle)
UV exposure by 2 pieces black light 20W in a distance of 5 cm.

Initial

1 hour later

4 hours later

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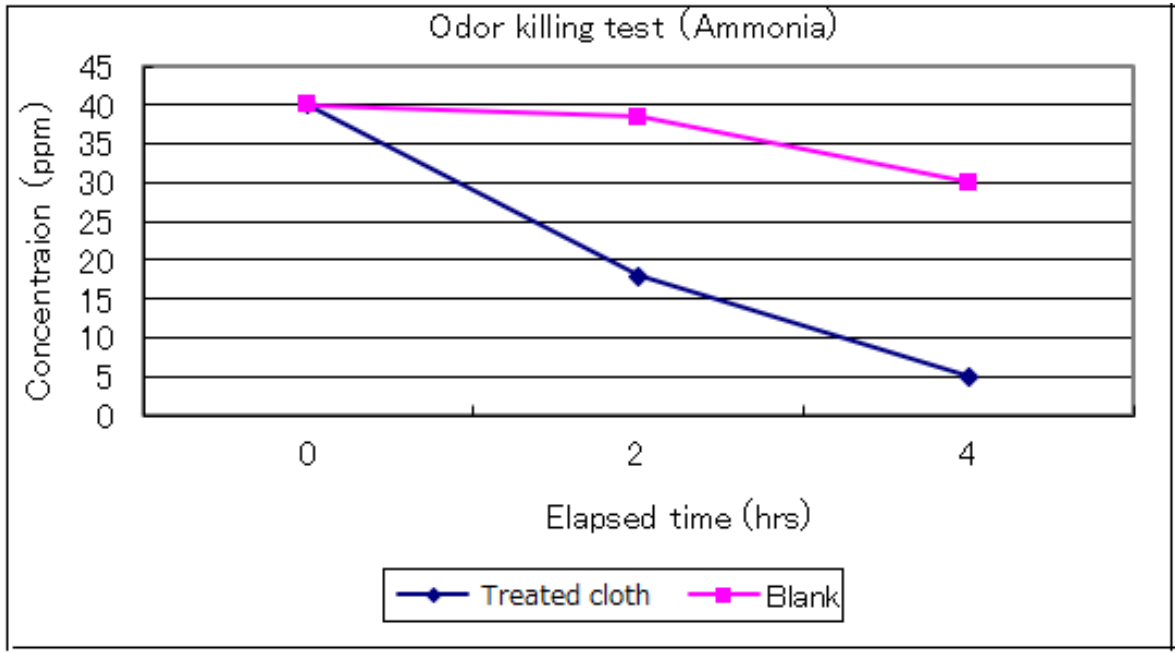
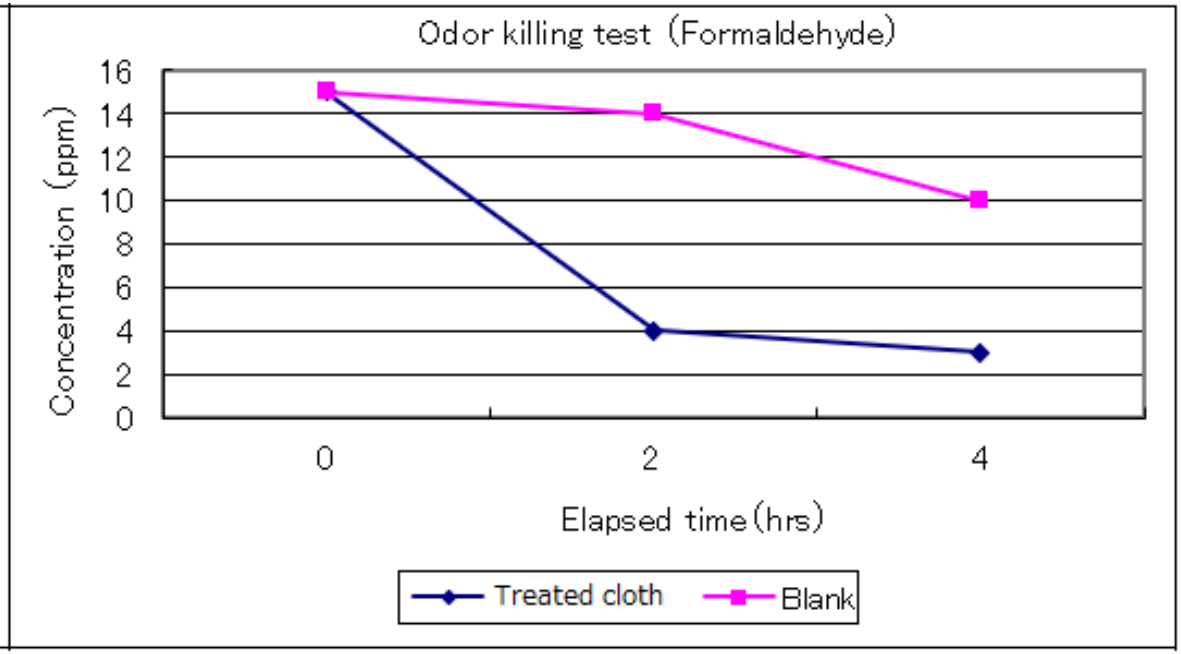
Test data (7)—Odor killing property to ammonia/formaldehyde

To Ammonia / Formaldehyde

Test conditions: **GAEA CLEAN treated cloth** (100% cotton 10 cm x 10 cm) and blank were forced to absorb specified odorous gas in tedlar bags. It was exposed to fluorescent light. Then, the concentration were measured by detecting tube.





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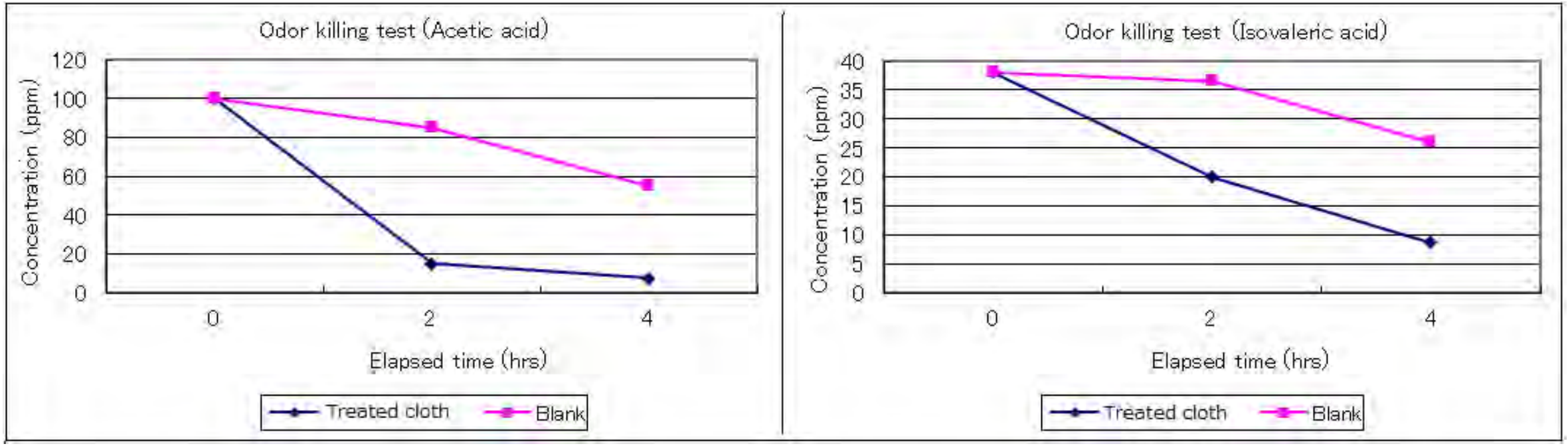
Test data (8)—Odor killing property to acetic acid/isovaleric acid

To Acetic acid / Isovaleric acid

Test conditions: **GAEA CLEAN treated cloth** (100% cotton 10 cm x 10 cm) and blank were forced to absorb specified odorous gas in tedlar bags. It was exposed to fluorescent light. Then, the concentration were measured by detecting tube.



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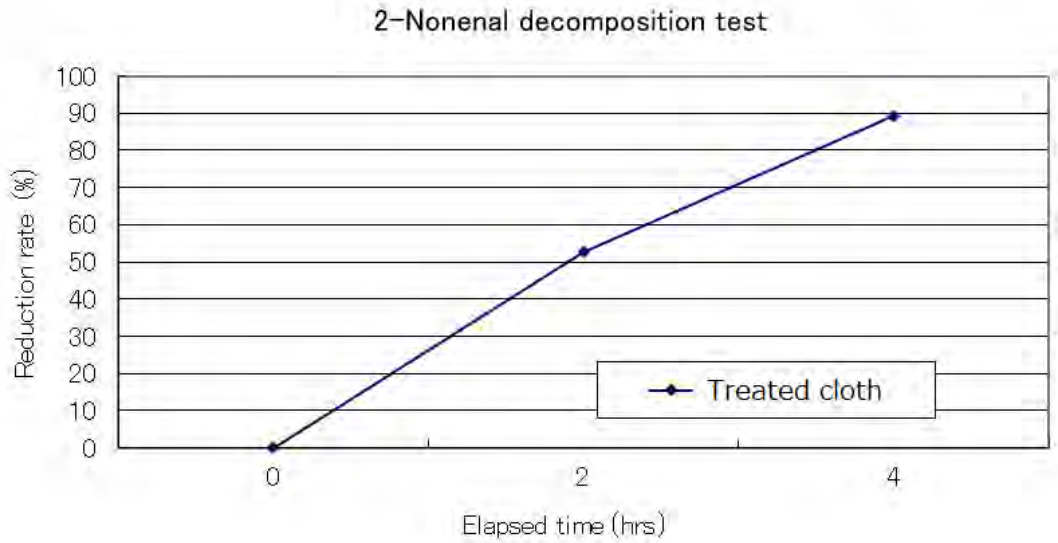
Test data (9)—Miscellaneous

1) It has been confirmed that 2-nonenal—newly found in human body odor tends to increase with aging was decomposed by **GAEA CLEAN's** photocatalytic action.

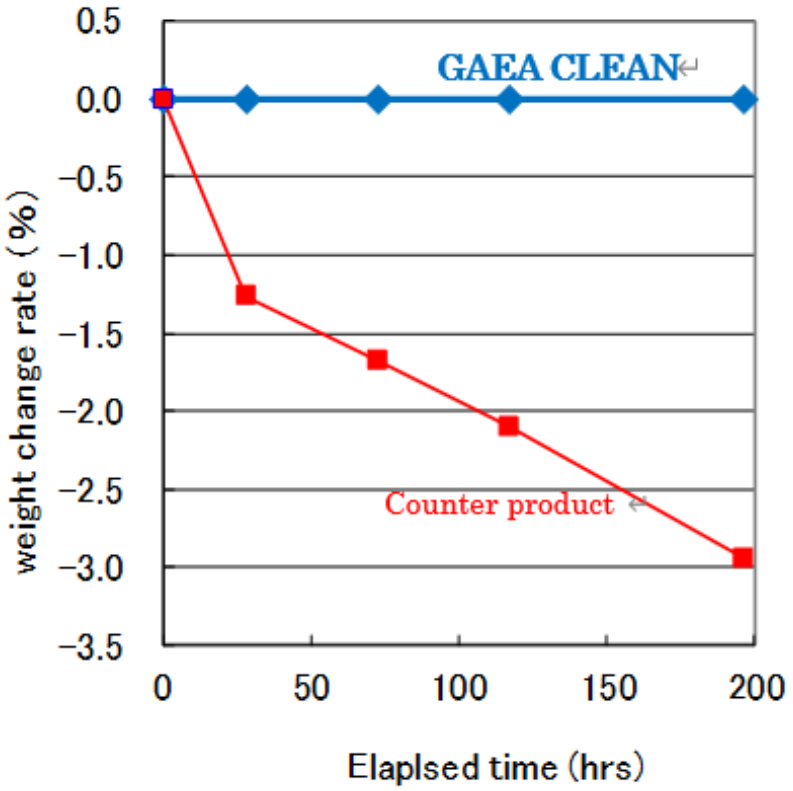


2) **GAEA CLEAN treated cloth** have superior UV shield property than regular fabric.

UV shield rate : 90.5 (treated cloth)
80.1 (blank)

measured in the range of wavelength between 280 and 400 nm.

3) It has been confirmed that the photocatalytic action does not affect the quality of substrate (in terms of fiber weight).



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Test data (10)—Antivirus property to phage Q-Beta

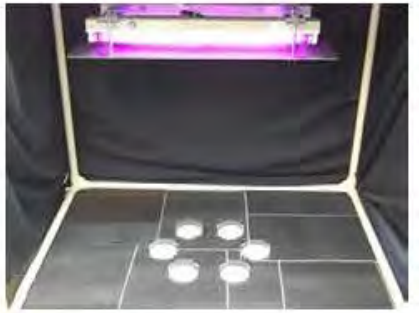
Sample 50 mm x 50 mm (n = 1)	Virus Infectivity Titer (pfu/sample)			Antiviral activity (day light) $V_{0.25}$	Photoexposure effect ΔV
	Initial 0.3ml 5.7×10^6	4 hours later with day light 0.25 mW/cm^2	4 hours later in dark place		
GAEA CLEAN treated cloth	--	7.5×10^1 (1.9) (C_L)	6.7×10^5 (5.8) (C_D)	**3.7**	**3.8**
Non treatment Blank	--	4.7×10^5 (5.7) (B_L)	6.2×10^5 (5.8) (B_D)		

[Reference]

Antivirus activity (day light)	$[V_L] = \text{Log}(B_L) - \text{Log}(C_L)$
Antivirus activity (dark place)	$[V_D] = \text{Log}(B_D) - \text{Log}(C_D)$
Photoexposure effect	$[\Delta V] = V_L - V_D$
Phage/host used in the test	Bacteriophage Qβ (NBRC20012) E.Coli (NBRC106373)

[Glass contact method]

[inoculation under UV radiation]



The test was conducted by Kanagawa Institute of Industrial Science and Technology (KISTEC) in accordance with JIS R1706 (ISO 18061) and R1702 (ISO 27447) glass contact method.

Criteria : 2.0 or more on antivirus activity (day light) V_L under JIS R1706 / ISO 18061

0.3 or more on photoexposure effect ΔV under JIS R1706 / ISO 18061

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Details on antivirus performance test (1)

The following explanation is focused on the evaluation of antivirus performance by TiO_2 photocatalyst based on the test standard JIS R1706 / ISO 18061: Determination of antiviral activity of semiconducting photocatalytic materials — Test method using bacteriophage Q-beta.

<u>Virus and Bacteriophage</u>

Viruses cannot generate their own energy, but they can be only replicated inside the living host cells of a organism. In general, virus refers to tiny organic material that can infect organisms including animals, human, and plants. Bacteriophage refers to a type of virus that can infect bacteria. Bacteriophage has been widely used as an experimental substitute to any viruses because it can be easily handled.

Table: difference between virus and bacteia

Characteristics	Virus (Bacgteriophage)	Bacteria
Self-replication	Incapable (replicalbe in host cells)	Capable
Energy generation	Incapable	Capable
Nucleic acid	Either DNA or RNA	Both of DNA and RNA
Dimension	0.02~0.2 μm (20~200 nm)	1~10 μm
Structure	Noncell Nucleic acid Protein Envelope (lipid bilayer membrane) (e.g.) Influenza virus, ϕ6 Bacteriophage, etc. Non-envelope (e.g.) Norovirus, QβBacteriophage, etc.	Monocyte Nucleic acid Cell wall Cell membrane Protein

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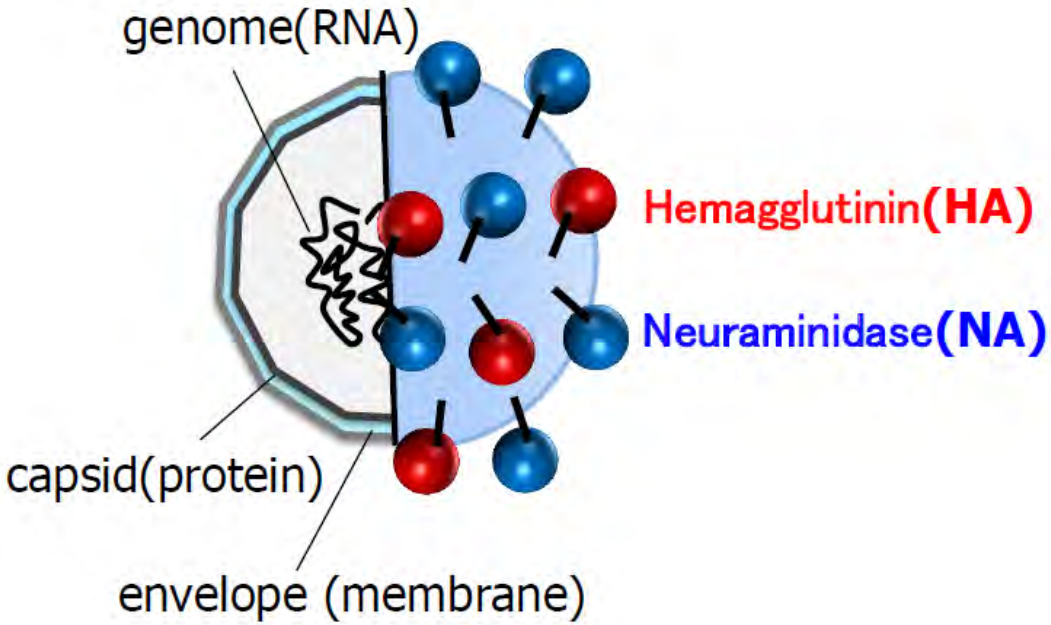
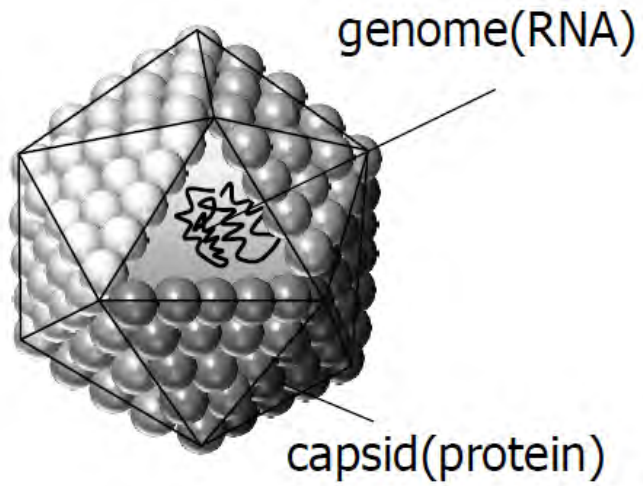
Details on antivirus performance test (2)

Virus classification

Viruses are broadly classified as either enveloped (lipid bilayer membrane) or non-enveloped viruses. Influenza virus(dia. 1) is a typical enveloped virus. On the other hands, norovirus (dia.2) is a typical non-enveloped virus. When it comes to bacteriophage, bacteriophage φ6 is of enveloped type, and bacteriophage Qβ, mainly used for the evaluation of antivirus performance of photocatalyst, is of non-enveloped type.



Dia. 1. Schematic image of influenza virus



Dia. 2. Schematic image of norovirus

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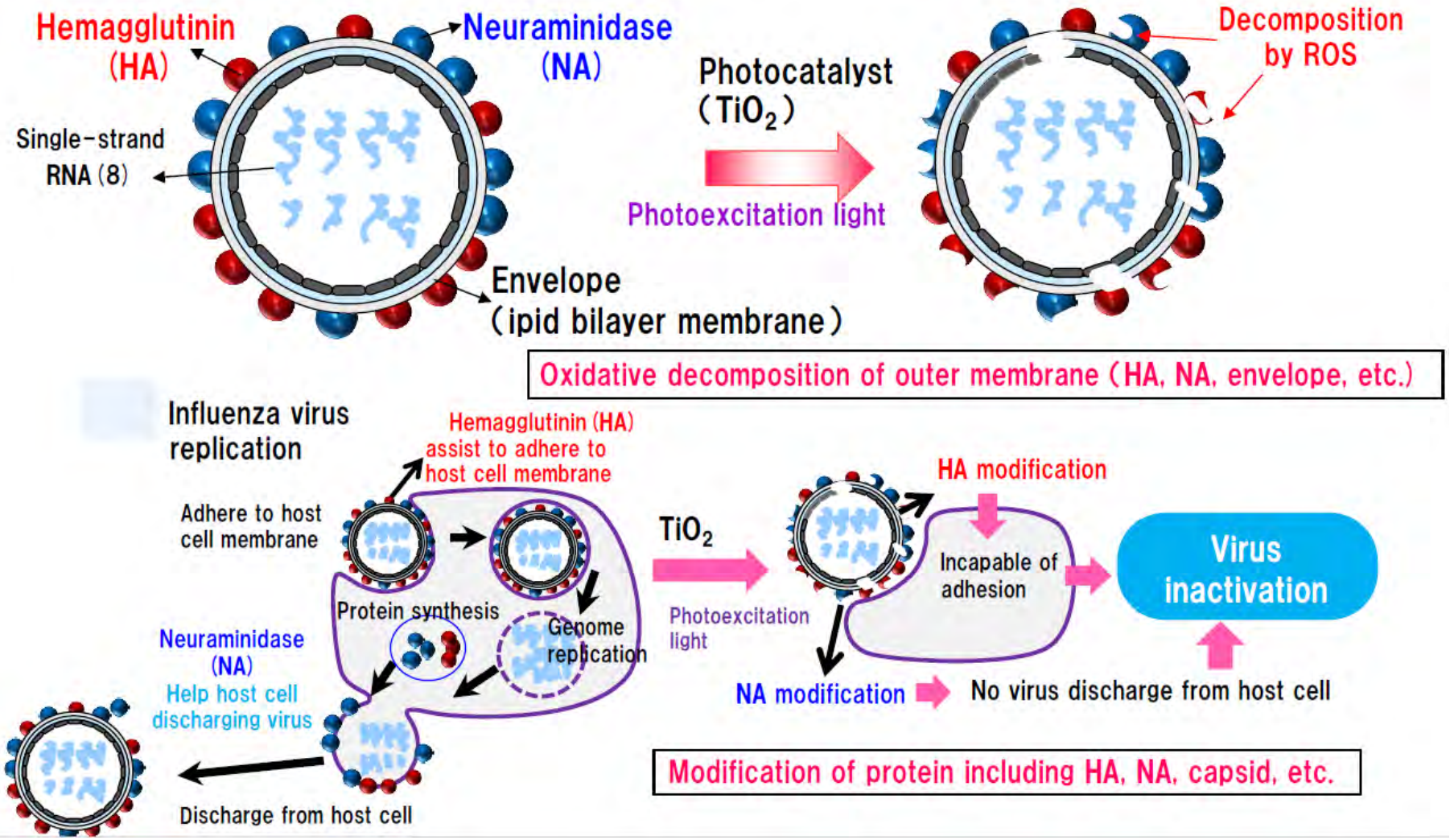
Details on antivirus performance test (3)

Mechanism of antivirus performance by photocatalyst

Photocatalytic activity involves the generation of reactive oxygen species (ROS) that can decompose viral outer membrane (envelope or capsid) and inhibit virus activity (infectivity).



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Details on antivirus performance test (4)

Summary: mechanism of antivirus performance by photocatalyst

- **Oxidative decomposition by photocatalyst is not selective, that can inhibit any viruses regardless of their types. Thus, it is considered that it is effective to a mutant virus.**

- **In general, non-enveloped viruses are resistant to ethanol-based disinfectants. However, antivirus activity carried out by photocatalyst can reach the both enveloped and non-enveloped viruses.**

- **Antivirus activity carried out by photocatalyst occurs only on the surface of the photocatalyst. When it comes to the effect to viruses in the air, antivirus activity may reach when viruses contact to the surface of photocatalyst.**

Definition of "antivirus activity" by photocatalyst

It is defined that antivirus activity by photocatalyst is to inhibit virus activation and/or infectivity on the surface of photocatalyst.

- **Antivirus activity by photocatalyst is determined via evaluation of the effect to the index virus, Bacteriophage Qβ (NBRC 20012). It is supposed that the effect may cover all of viruses, but it is not obliged to guarantee the effect to a specific type of viruses.**

- **The evaluation is not a product to indicate the prevention or treatment of diseases.**

- **Antivirus activity by photocatalyst occurs only on the surface of the photocatalyst, but not in the space.**

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Details on antivirus performance test (5)

Why Bacteriophage Qβ is used

In order to evaluate antivirus activity of photocatalyst, the index virus, bacteriophage Qβ (NBRC 20012) has been used as provided in the test standard JIS R1706 (ISO 18061) and JIS R1756 (ISO 18071).

- **The mechanism of antivirus activity by photocatalyst shows that the effect can be expected to the both animal viruses and bacteriophages.**
- **Bacteriophage Qβ is of non-enveloped virus that is generally resistant to disinfectants. In other words, the evaluation test using Bacteriophage Qβ is severe.**
- **Correlation between the effect to animal viruses and bacteriophage Qβ can be confirmed with accumulated data kept by NEDO, JIS and PIAJ.**
- **The evaluation test by using bacteriophage Qβ is more accurate and reproductive because it is harmless to human body and easy to acquire the highly concentrated culture liquid with little impurity. By contrast, the test by using an animal virus requires safety measures and tends to be poor in accuracy and reproductivity affected by contaminants.**

In summary, it has been judged that obvious proof of the effect to bacteriophage Qβ can claim the same effect to animal viruses, and the use of bacteriophage Qβ is reasonable in terms of accuracy and reproductivity.

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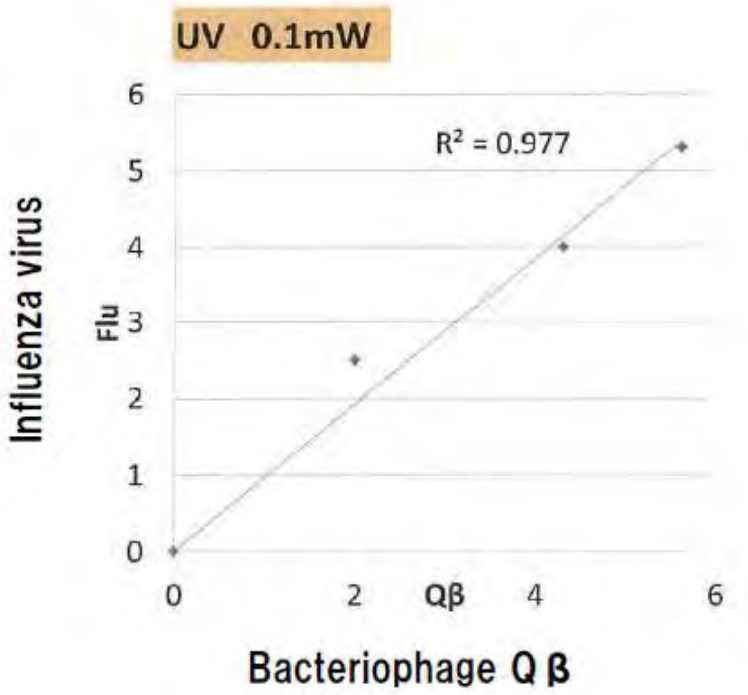
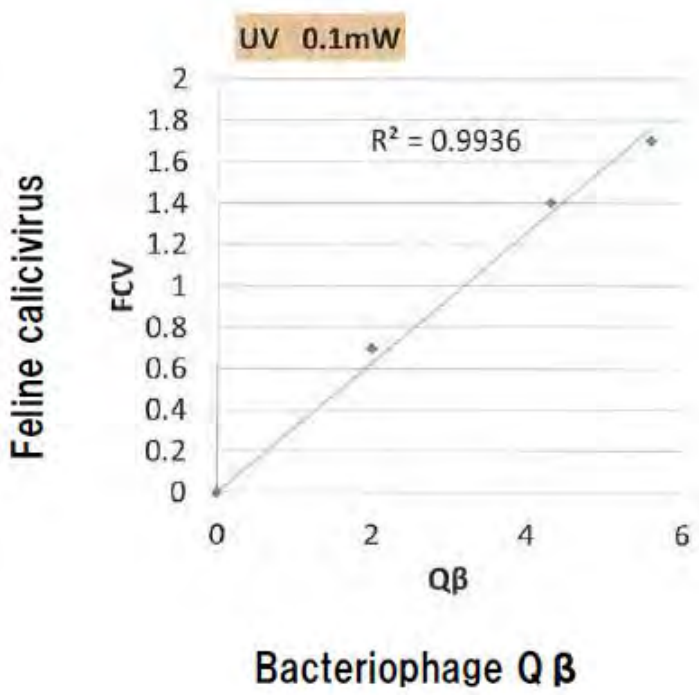
Details on antivirus performance test (6)

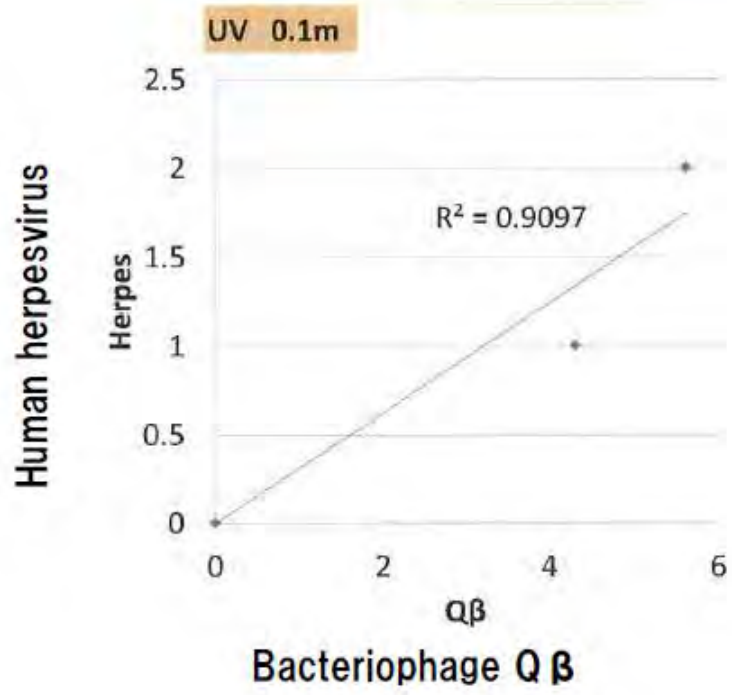
Data correlation: animal viruses vs. bacteriophages

The graphs show correlation of antivirus activity by photocatalyst between animal viruses and bacteriophages.

Graphs: Correlation of antiviral activity index of bacteriophage Qβwith specified animal viruses







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Test standard — JIS/ISO harmonization

Test methods for the evaluation of photocatalytic effect have been standardized by JIS after long years of study and judgement by Photocatalyst Industry Association of Japan (PIAJ) and its members and globally harmonized with ISO.

Test methods standard for the evaluation of photocatalytic effects (as of April 2019 compiled by PIAJ)
Note) The numbers in parentheses show the year of establishment or the latest revision.

Category	Test method	Ultraviolet light	
		JIS number	ISO number
Self-Cleaning	Water contact angle	R1703-1 (2007)	ISO 27448 (2009)
	Methylene blue decomposition	R1703-2 (2014)	ISO 10678 (2010)
	Resazurin ink decomposition	-	ISO 21066 (2018)
Air purification	Nitrogen oxides	R1701-1 (2016)	ISO 22197-1 (2016)
	Acetaldehyde	R1701-2 (2016)	ISO 22197-2 (2011)
	Toluene	R1701-3 (2016)	ISO 22197-3 (2011)
	Formaldehyde	R1701-4 (2016)	ISO 22197-4 (2013)
	Methyl mercaptan	R1701-5 (2016)	ISO 22197-5 (2013)
Water quality	Dimethyl sulfoxide	R1704 (2007)	ISO 10676 (2010)
Oxidation	Dissolved oxygen	R1708 (2016)	ISO 19722 (2017)
	Total Organic Carbon (TOC)	-	DIS 22601
Antibacterial & Antivirus property	Antibacterial	R1702 (2012)	ISO 27447 (2009)
	Antifungus	R1705 (2016)	ISO 13125 (2013)
	Alga proofing	-	ISO 19635 (2016)
	Antivirus	R1706 (2013)	ISO 18061 (2014)
Light source	Standard light source	R1709 (2014)	ISO 10677 (2011)

Process of establishment : AWI → WD → CD → DIS → FDIS → ISO

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PIAJ performance standard (1)

Standards for Determining Performance of Self-cleaning Functions

1) Test Methods for Evaluating Self-cleaning Functions
JIS R 1703-1 Fine Ceramics – Test Method for Evaluating Self-cleaning Performance of Photocatalyst Materials – Part 1: Measurement of Water Contact Angle
JIS R 1703-2 Fine Ceramics – Test Method for Evaluating Self-cleaning Performance of Photocatalyst Materials – Part 2: Wet Decomposition Performance

2) Criteria
JIS R 1703-1: Critical contact angle is below 30 degrees
JIS R 1703-2: Decomposition index is above 5

3) Durability of Effects
Depends on manufacturer's self-certification of standard.

4) Safety (Mandatory Test Items)
Peroral Acute Toxicity: LD50 ≥ 2,000mg/kg
Primary Skin Irritation Test: No Irritation or mild irritation
Mutation Test: Negative mutagenicity
Skin Sensitization Test: Negative

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PIAJ performance standard (2)

Standards for Judging Antibacterial Performance

1) Test Method for Evaluating Antibacterial Performance
JIS R 1702　Fine Ceramics – Antibacterial Test Method for Evaluating Photocatalyst Antibacterial Finishing Products and Their Antibacterial Effects under Light Irradiation

2) Criteria
(Photocatalyst Antibacterial Finishing Products: Film Contact Method)
RL ≥ 2.0 (UV Luminous Intensity: Required Value) *　⊿R ≥ 0.3 (UV Luminous Intensity: Required Value)*
(Photocatalyst Antibacterial Finishing Fiber Products: Glass Contact Method)
SL ≥ 2.0 (UV Luminous Intensity: Required Value) *　⊿S ≥ 0.3 (UV Luminous Intensity: Required Value)*

*** "UV Luminous Intensity: Required Value" is the intensity of ultraviolet rays at locations where applicable products are supposed to be used or applicable products claim to produce photocatalystic antibacterial effects.**

3) Durability of Effects
Depend on manufacturer's self-certification of standard.

4) Safety (Mandatory Test Items)
Peroral Acute Toxicity: LD50 ≥ 2,000mg/kg
Primary Skin Irritation Test: No Irritation or mild irritation
Mutation Test: Negative mutagenicity
Skin Sensitization Test: Negative

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PIAJ performance standard (3)

Standards for Determining Performance of Air Purification Function (Nitrogen Oxide)

1) Test Method for Evaluating Air Purification Function (Nitrogen Oxide)
JIS R 1701-1 Fine Ceramics -- Test Method for Determining Photocatalyst Materials' Air Purification Performance -- Part 1: Performance for Removing Nitrogen Oxide

2) Criteria
JIS R 1701-1 Removal quantity of nitrogen oxide is above 0.50μmol.
(However, it is possible to measure the amount of nitrogen oxide under the condition that 1.5L/min of test gas flows and two test pieces are used.)

3) Durability of Effects
Depend on manufacturer's self-certification of standard.

4) Safety (Mandatory Test Items)
Peroral Acute Toxicity: LD50 ≥ 2,000mg/kg
Primary Skin Irritation Test: No Irritation or mild irritation
Mutation Test: Negative mutagenicity
Skin Sensitization Test: Negative

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PIAJ performance standard (4)

Standards Standards for Determining Performance of Air Purification Function (Acetaldehyde)

1) Test Method for Evaluating Air Purification Function (Nitrogen Oxide)
JIS R 1701-2 Fine Ceramics -- Test Method for Determining Photocatalyst Materials' Air Purification Performance -- Part 1: Performance for Removing Acetaldehyde

2) Criteria
JIS R 1701-2 Removal quantity of acetaldehyde is above 0.17μmol.

3) Durability of Effects
Depend on manufacturer's self-certification of standard.

4) Safety (Mandatory Test Items)
Peroral Acute Toxicity: LD50 ≥ 2,000mg/kg
Primary Skin Irritation Test: No Irritation or mild irritation
Mutation Test: Negative mutagenicity
Skin Sensitization Test: Negative

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Textile products example by GAEA CLEAN (1)

T-shirts

Medical wear

White-shirts

Polo-shirts

White robe

Men's suits

Kashimir-sweaters

Underwear

Bedding-sheet

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Textile products example by GAEA CLEAN (2)

Micro-fiber

Carpets

Car-sheet cover

Car-interior

Artificial flower

Roofing film

Wall paper&film

Spray

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