



## **Plasmacluster Ions™\*1 Inactivate an Airborne Corona Virus—A World First<sup>2</sup>**

### **Verification Research Conducted Jointly with the Kitasato Institute**

Recently, new viral-based infectious diseases such as SARS (corona viruses) and avian influenza (orthomyxoviruses) have made their appearance, and cases that threaten human health are on the increase. In seeking new technologies for purifying the air, Sharp has systematically verified the efficacy of Plasmacluster Ions™ in deactivating harmful substances that are the cause of illnesses spread through the medium of the air.

Now, in collaboration with Director & Visiting Professor Tatsuo Suzuki PhD and Assistant Director Noritada Kobayashi PhD of the Kitasato Institute Medical Center Hospital, one of the world's most prestigious viral research organizations, we have verified that Plasmacluster Ions™ inactivate the feline corona virus (FCoV), a member of the Coronaviridae (corona virus) family. The results demonstrated that 99.7% of the virus is rendered inactive within 40 minutes. In other words, we proved that Plasmacluster Ions™ work to destroy the virus and control its capacity to infect.

These results have now enabled us to demonstrate the efficacy of Plasmacluster Ions™ against three basic types of major pathogenic viruses that infect by aerosol transmission (inhalation).

Plasmacluster Ion™ technology is Sharp's proprietary air purification technology in which large numbers of positive and negative ions are generated from airborne



water and oxygen molecules and then released back into the air in large quantities. These ions form clusters around microparticles such as airborne mold, influenza viruses and mite allergens, and render them inactive through a chemical reaction. Sharp developed this air purification technology in 2000, and is working with leading academic research institutions around the world to verify its effectiveness. Based on the scientific data that emerges from this industry-academia collaboration, Sharp will develop and introduce new products to the market.

**New Points Verified at this Time**

- Demonstrated that Plasmacluster Ions™ render inactive an airborne feline corona virus in the Coronaviridae family.
- Directly confirmed that the virus was in an inactive state using TEM (transmission electron microscopy).

**Classification System for Viruses Against Which Plasmacluster Ions Have Proven Effective**

  Proven effective

Nucleic Acid	Family Name	Primary Viruses	Primary Disease/Disorder	Date of Announcement of Verification of Effectiveness
<b>RNA</b>	<b>Picornaviridae</b>	<b>Polio virus</b>	<b>Infantile paralysis (poliomyelitis)</b>	<b>September 2002</b>
		<b>Coxsackie virus</b>	<b>Summer colds</b>	<b>September 2002</b>
	<b>Coronaviridae</b>	<b>Feline corona virus</b>	<b>Vomiting, diarrhea</b>	<b>July 2004</b>
		Human corona virus	Colds	—
		SARS virus	Sudden Acute Respiratory Syndrome (SARS)	—
<b>Orthomyxoviridae</b>	<b>Influenza virus</b>	<b>Influenza</b>	<b>September 2002</b>	
DNA	(No DNA-based virus causing major illness infects through aerosol transmission.)			

Note: We are currently involved in verifying the effectiveness of Plasmacluster Ions™ to inactivate the airborne SARS virus.



\*1 Plasmacluster and Plasmacluster Ion are trademarks of Sharp Corporation.

\*2 Current as of July 27, 2004, using Plasmacluster Ion™ technology.

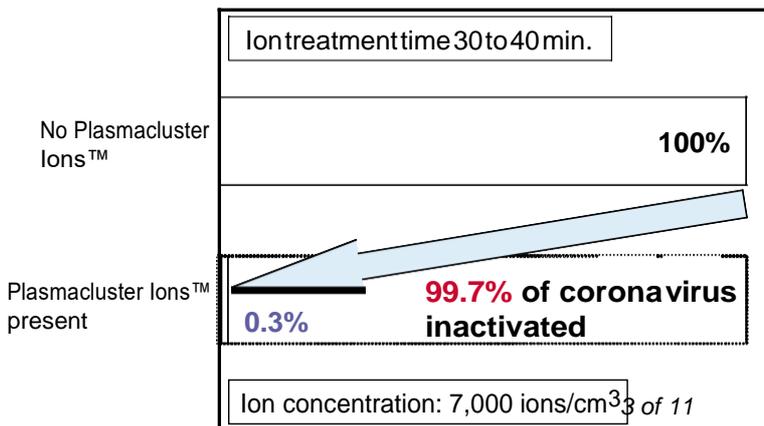
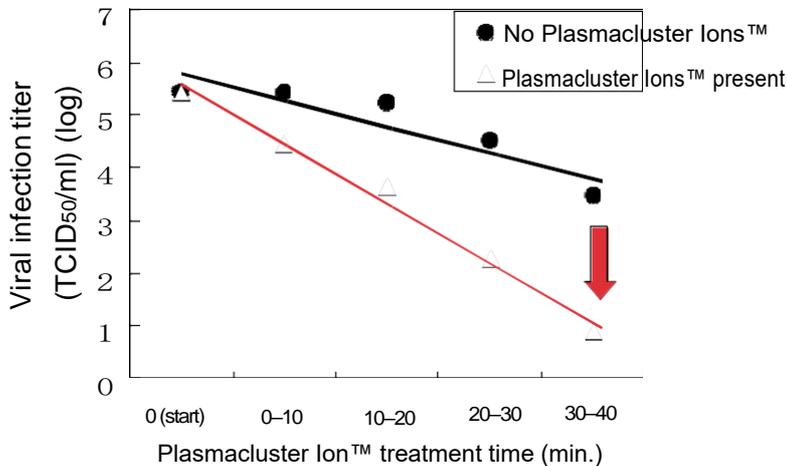
**Method Used to Verify Inactivation of Airborne Corona Virus/Room Simulation**

**Test**

A test was conducted by preparing two boxes, each having a volume of one (1) m<sup>3</sup>. A Plasmacluster Ion™ generator was placed in one box; the other box was left empty. An aerosolized mist of feline corona virus was sprayed into both boxes, and the respective inactivation effects compared. (The TCID<sub>50</sub> [Tissue Culture Infectious Dose 50%] assay was used to evaluate the test results. This assay measures the quantity of a virus suspension that will infect 50% of cell culture and is widely used in the field of virology.)

The results showed that 99.7% of the virus exposed to the ions was inactivated within 40 minutes. This is thought to be the result of ions damaging the virus by stealing hydrogen (H) from the peplomers (“spikes” made of protein) by which the virus infects cells. An inactivated corona virus cannot infect a host even when introduced into the body.

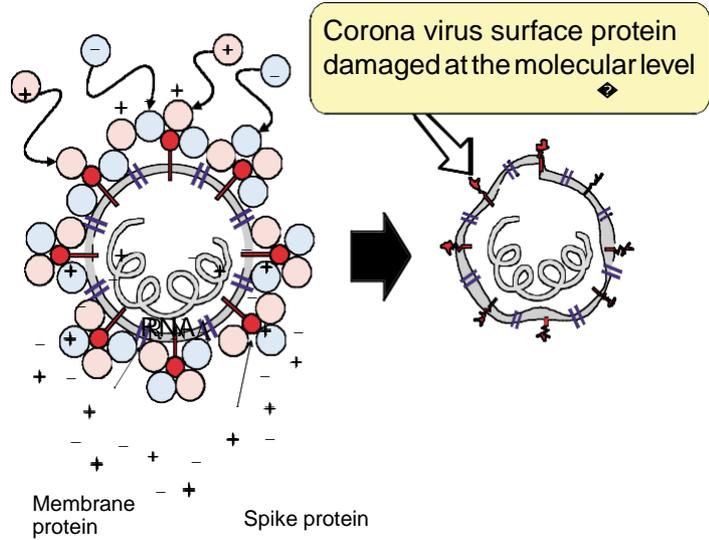
Evaluation of efficacy against airborne corona virus





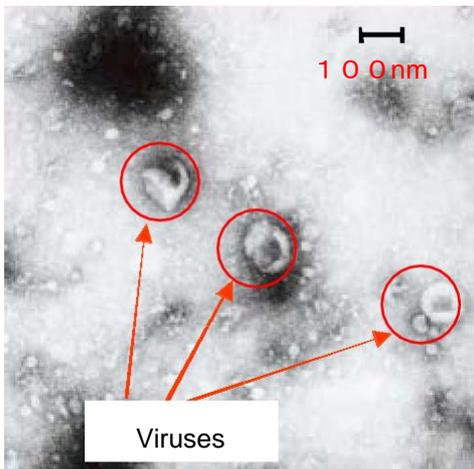
**Inactivation mechanism**

Positive ions (H<sup>+</sup>) and negative ions (O<sub>2</sub><sup>-</sup>) cluster around the spike protein (a surface protein that attaches to an organism and triggers the infection) of the airborne virus, and are converted to hydroxyl radicals (•OH), a powerfully active substance. By stealing H (hydrogen) from within the spike protein, the ions react and combine chemically to form water (H<sub>2</sub>O). Because the spike protein is damaged, the virus cannot infect cells even when introduced into the body.



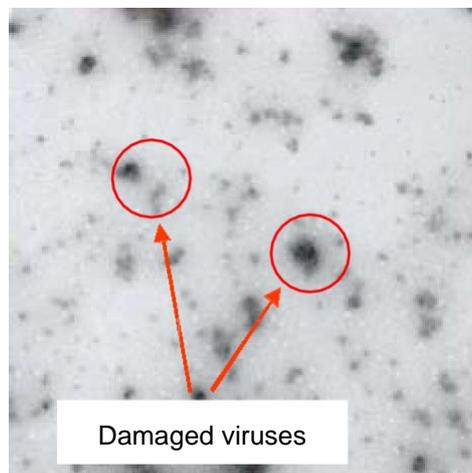
**Electron microscope image showing inactivated state**

Viruses **not** exposed to Plasmacluster Ions™



Corona virus when not exposed to the action of Plasmacluster Ions™  
[retaining their normal shape]

Virus exposed to Plasmacluster Ions™



Corona virus when exposed to the action of Plasmacluster Ions™  
[damaged and collapsed]



## **Comments by Doctors Tatsuo Suzuki and Noritada Kobayashi of the Kitasato Institute on Plasmacluster Ions™**

In the electron microscope photograph, normal corona virus can be observed when no Plasmacluster Ion™ treatment is applied, but when exposed to Plasmacluster Ions™, no normal corona viruses can be observed, and what appears to be decomposed matter in which the spikes (protein protrusions) and envelope (surface membrane) on the virus surface are damaged is evident. This can be attributed to “the virus being decomposed by the Plasmacluster Ions™.”

Prior to carrying out the test, we were skeptical that the Plasmacluster Ions™ would actually have an antimicrobial effect. But we maintained an open mind, and when we conducted the performance test, it was a fact that there was a dramatic reduction in bacteria and viruses in the presence of Plasmacluster Ions™. We can imagine that this technology will have tremendous utility and huge potential for practical applications.

### **Overview of Plasmacluster Ion™ Technology**

Positive ( $H^+$ ) ions and negative ( $O_2^-$ ) ions generated by a plasma discharge have the property of forming clusters around micro particles. They surround harmful substances such as airborne fungi, influenza viruses and mite allergens. At this point, a chemical reaction occurs, and the collision of two  $H^+$  ions and an  $O_2^-$  ion creates highly reactive  $OH^-$  groups called hydroxyl radicals ( $\bullet OH$ ). A hydroxyl radical is unstable and to stabilize itself, it will rob one hydrogen (H) from any harmful airborne particle it encounters, inactivating it and forming water ( $H_2O$ ) vapor in the process, which is returned to the air.

1. These positive and negative ions are the same ions found in abundance in nature, such as in the forest, and are completely harmless to humans. Ozone generation is less than 0.01 ppm, much lower than the industry and consumer electronics standard of 0.05 ppm.
2. Compared to passive air cleaning systems that filter out contaminants by using the power of a fan to pull air through a filter, air cleaning systems that utilize Plasmacluster Ion™ technology are significantly more effective in cleaning the air in the interior of an entire room, including stagnant air which is not able to go through a filter.
3. Plasmacluster Ion™ generating units are continuously effective, as they do not become clogged with dirt like a filter and do not require changing or cleaning filters. They are environmentally conscious devices that use water molecules in the air and save electricity costs (approx. 0.5W power consumption, annual electricity cost of approx. 100 yen [\$0.91]).



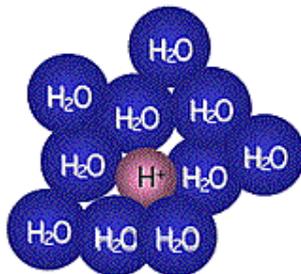
## Plasmacluster Ion™ Generating Device



Unit: mm

## **Chemical Composition and Structure of Plasmacluster Ions™**

(confirmed using a time-of-flight mass spectrometer)  
Positive and negative ions surrounded by water molecules



Positive ions  $H^+(H_2O)_n$



Negative ions  $O_2^-(H_2O)_m$



**Efficacy of Plasmacluster Ion™ Technology on Various Pathogens (total 11)**

Target Material	Type	Testing & Verification Organization	Date
Virus	Corona virus	Kitasato Institute Medical Center Hospital	July 2004
	Influenza virus	Kitasato Research Center of Environmental Sciences	Sept. 2002
		Seoul University, Korea	Sept. 2003
		Shanghai Municipal Center for Disease Control and Prevention, China	Dec. 2003
		Kitasato Institute Medical Center Hospital	Feb. 2004
Coxsackie virus	Kitasato Research Center of Environmental Sciences	Sept. 2002	
Polio virus	Kitasato Research Center of Environmental Sciences	Sept. 2002	
Allergens	Mite allergen (dust from dead mite bodies and feces)	Graduate School of Advanced Sciences of Matter, Hiroshima University	Sept. 2003
	Pollen allergen (cedar pollen)	Graduate School of Advanced Sciences of Matter, Hiroshima University	Sept. 2003
Bacteria	MRSA (methicillin-resistant Staphylococcus aureus)	Kitasato Research Center of Environmental Sciences	Sept. 2002
		Kitasato Institute Medical Center Hospital	Feb. 2004
	Coliform bacteria (E. coli)	Ishikawa Health Service Association	Sept. 2000
	Bacilli	Kitasato Research Center of Environmental Sciences	Sept. 2002
Bacteria (Coliform bacteria, Staphylococcus)	Shanghai Municipal Center for Disease Control and Prevention, China	Oct. 2001	
Fungi	Cladosporium (black mold)	Ishikawa Health Service Association	Sept. 2000
		Shanghai Municipal Center for Disease Control and Prevention, China	Jan. 2001
		Lübeck University Clinic, Germany	Feb. 2002



### **What is a corona virus?**

The corona virus is spherical in shape with a diameter of from 60 to 220 nm. Its structure consists of an RNA nucleus enclosed within a sack-like envelope made of protein, along with spike-like protrusions on its surface approximately 20 nm in length consisting of a glycoprotein.

Various types of corona viruses infect humans as well as cats, birds, dogs and rodents. In animals, it causes diseases of the respiratory organs, intestinal tract, and internal organs such as the liver. In humans, it generally causes respiratory diseases, and is regarded as the cause of 10% to 30% of all colds.

### **Profile of the Kitasato Institute Medical Center, Research Division**

The Kitasato Institute was founded in 1914 by Dr. Shibasaburo Kitasato to contribute to the improvement of the health of the nation by researching the causes of diseases and approaches to preventative treatments, and by operating medical treatment facilities. Dr. Kitasato gained world renown through his discovery of tetanus immune antibodies following on his success in growing a pure culture of the tetanus bacillus. He placed great importance on the ideas of the practical sciences, and devoted his time to public health propagation and development.

As a leader in advanced leading-edge medical treatment, the Research Division of the Kitasato Institute Medical Center Hospital is involved in numerous clinical investigations as well as basic research. As part of these programs, we established a Medical Environmental Science Center within the Institute in conjunction with setting up infection control hospital rooms. We are engaged in R&D with the goal of improving and enhancing the healthcare environment from a comprehensive perspective. To constantly maintain medical care at the highest levels, we have established a Biomedical Laboratory as a place where a large number of clinical investigations and basic research can be conducted. This laboratory maintains the highest standards of cleanliness, and incorporates facilities to enable a wide variety of research ranging from basic research to clinical studies, including in particular, laboratory animal facilities, as well as a cytology laboratory, physical science laboratory, nucleic acid laboratory, and cellular analysis laboratory. The laboratory serves as a pillar supporting advanced medicine. Research focuses on infectious diseases, cancer, and geriatrics, and is conducted by a staff who are highly knowledgeable in immunology and microbiology. In addition, we give the highest priority to the hospital environment, and we are also developing new chemotherapy agents and antiseptics, working within a framework of cooperation with the Medical Environmental Science Center of the Kitasato Institute.



Dr. Tatsuo Suzuki

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Chief, Division of Biomedical Research  
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Visiting Professor, Kitasato University  
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Dr. Noritada Kobayashi

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(Specialties) Immunology, molecular immunology, microbiology



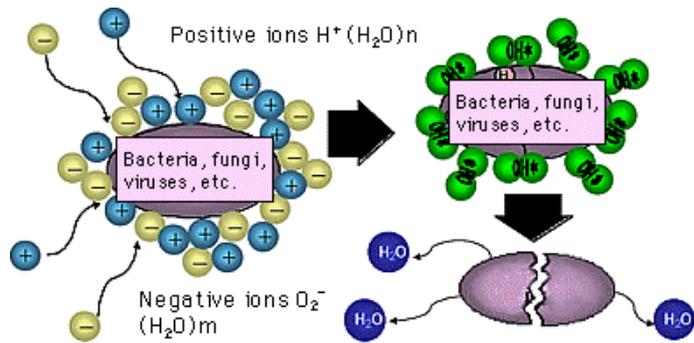
**[Reference]**

**Mechanism for Inactivating Airborne Fungi**

The positive and negative ions cluster together on the surface of airborne fungi, causing a chemical reaction that results in the creation of highly reactive OH groups called hydroxyl radicals ( $\bullet$ OH).

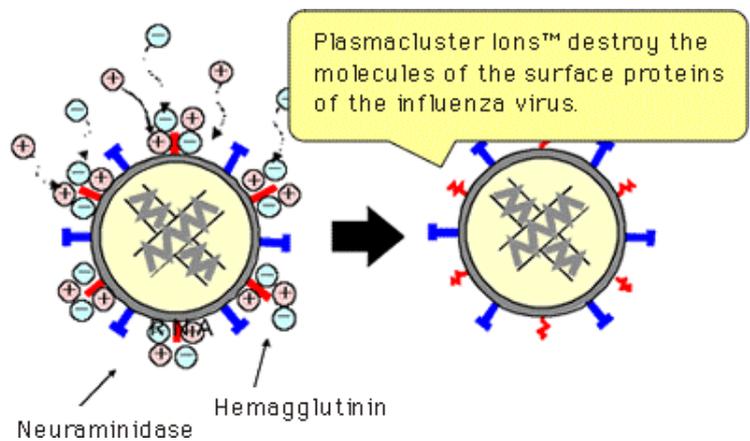
The hydroxyl radical will take a hydrogen molecule from the cell wall of an airborne fungi particle, thus inactivating it.

Inhibits mold infestation as well as controls musty and household odors (caused in large part by mold fungi) as they occur.



**Mechanism for Inactivating Airborne Influenza Virus**

The positive and negative ions surround the hemagglutinin (surface proteins that form on organisms and trigger infections) and change into highly reactive OH groups called hydroxyl radicals ( $\bullet$ OH). These take a hydrogen molecule from the hemagglutinin and change into water ( $H_2O$ ). The hemagglutinin molecules are destroyed so the virus cannot infect even if it enters someone's body.





### Mechanism for Deactivating Airborne Allergens

Plasmacluster Ions™ surround the airborne allergen and change into highly reactive hydroxyl radicals ( $\bullet\text{OH}$ ). The hydroxyls then deactivate the molecules of the IgE antibody binding site of the allergen. No allergic symptoms occur even if allergens enter the body.

