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News Release

March 8, 2018

Research Proves for First Time Ever*1 That Plasmacluster Ion Technology Inhibits Mold throughout Its Growth Stages*2

Sharp Corporation, under the supervision of mold research expert Professor Tsutomu Morinaga of the Prefectural University of Hiroshima, has demonstrated that Plasmacluster ion technology is effective in inhibiting mold throughout its growth stages. It can suppress by more than 99.9% the germination and growth of spores in five common types of mold*3 (which account for about 80% of mold that propagates in the average household). The test was conducted in a mold testing device*4 with an average Plasmacluster ion concentration of approximately 2 million ions/cm^3.

Mold is present in our living environments, not just polluting the interior and rotting our food but also having harmful effects on our health by, for example, causing infectious diseases and allergies. In 2004, Sharp demonstrated Plasmacluster's ability to inhibit mold*5. This latest testing has achieved more detailed verification and has shown that Plasmacluster ions can inhibit the propagation of mold in its various stages of growth.

Since 2000, Sharp has been conducting academic marketing*6 in which it works with world-class third-party research institutions. Under these collaborations Sharp demonstrated so far Plasmacluster's ability to inhibit harmful substances such as a new strain of influenza virus, drug-resistant bacteria, and mite allergens, as well as clinical effects such as reducing throat inflammation in child asthma patients*7. Plasmacluster ions have also been shown to be safe*8. Sharp will continue to conduct a range of Plasmacluster ion testing in its efforts to contribute to society.

Sharp plans to announce the details of this latest test on November 13, 2018 at a meeting of the Society for Antibacterial and Antifungal Agents, Japan, to be held in Edogawa-ku, Tokyo.

Comment from Professor Tsutomu Morinaga, Prefectural University of Hiroshima

The inhibition of mold is a major issue that we must tackle—not just in our homes but in factories, offices, and all other spaces where people live and work. With Japan's high humidity, the country is particularly susceptible to the propagation of mold.

Mold has a higher resistance than substances like viruses and bacteria. Because it propagates throughout its entire complex life cycle (growth stages), we know how difficult it is to control.

This latest test revealed that Plasmacluster ions not only inhibit airborne spores but also the growth of mycelia and the formation of spores, thus working to comprehensively inhibit the propagation of mold. This holds new promise for the inhibition of mold in homes, as well as in places where mold countermeasures are crucial, such as food processing plants and medical institutions.

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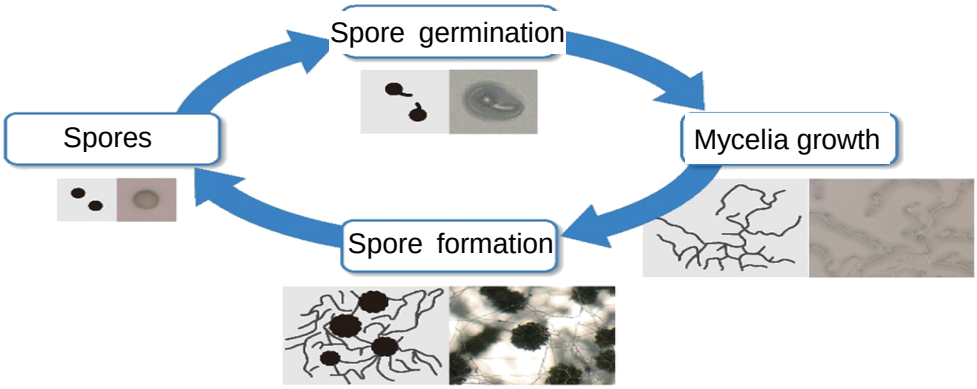
*1 World first for tests that verify the inhibitory effects in the growth stages of mold. (As of March 8, 2018; based on Sharp research.)
*2 The stages in mold's life cycle: the germination and growth of spores, mycelia growth and spore formation, and fully formed spores.
*3 Five types of mold used in JIS antimicrobial testing: (1) *Aspergillus niger*; Aspergillus, (2) *Penicillium citrinum*; Pencillium, (3) *Cladosporium cladosporioides*; Cladosporium, (4) *Rhizopus oryzae*; Rhizopus, (5) *Chaetomium globosum*; Chaetomium.
*4 Cylindrical testing device measuring 22.0 cm in diameter and 50.0 cm in height.
*5 Announced on November 17, 2004. Sharp revealed the mold inactivating mechanism of Plasmacluster ion technology.
*6 A marketing method in which a company collaborates with a leading research institute to gather and verify data on the effects of a certain technology, and then uses this data as the basis for commercialization of the technology.
*7 Announced on September 18, 2014.
*8 According to tests conducted by LSI Medience Corporation (inhalation toxicity test, eye and skin irritation/corrosion tests, teratogenicity test, and two-generation reproduction test).

■ Illustration of Mold Life Cycle (Growth Stages)



Life cycle of Aspergillus

■ Overview of Verification Test

- Test institute: Biostir Inc. (Supervision: Professor Tsutomu Morinaga, Prefectural University of Hiroshima)
- Test space: Cylindrical container measuring 22.0 cm in diameter and 50.0 cm in height
- Verification device: Plasmacluster ion generator (installed in cylindrical container)
- Plasmacluster ion concentration: Average of 2 million ions/cm^3 in cylindrical container
- Comparative test: Test without above-mentioned ion generator

Testing device

- Types of mold verified

Name		Main characteristics
①*Aspergillus niger*	Aspergillus	A common airborne fungus in homes. Besides causing allergies, it causes pulmonary aspergillosis by entering the lungs.
②*Penicillium citrinum*	Penicillium	A common airborne fungus in homes. It grows on food and produces mycotoxins.
③*Cladosporium cladosporioides*	Cladosporium	A common airborne fungus in homes. It grows on bath tiles and similar surfaces.
④*Rhizopus oryzae*	Rhizopus	A cause of mucormycosis, which occurs in immunocompromised people.
⑤*Chaetomium globosum*	Chaetomium	Besides being a cause of spoilage of grains, it causes decomposition of items such as clothing and books.

- Test method

(1) Verification of inhibitory effect on germination and growth of spores

A spore suspension of the fungus specimen was scattered on the medium, which was placed in the testing device and exposed to Plasmacluster ions for three days, after which the number of grown colonies was counted. The scattered spore number was measured using the dilution plate method (a method for examining the type and amount of microorganisms).

(2) Verification of inhibitory effect on mycelia growth and spore formation

Influence on mycelia was tested. To ensure there was no influence on spore germination, a strain of the fungus specimen was punctured using a platinum hook and was planted inside the medium (in the center). After this, the strain of the fungus specimen was cultivated for three days while being exposed to Plasmacluster ions. The mycelia growth and spore formation occurring on the medium surface were observed visually (using photographs) and compared.

(3) Verification of inhibitory effect on fully formed spores

A strain of the fungus specimen (from which spores were formed) was fully grown on the medium and then placed inside the testing device and subjected to three days of Plasmacluster ion exposure. After that, spores were extracted and scattered on a separate medium, and after 12 hours of cultivation, the germinated spores were counted under a microscope.

● Results

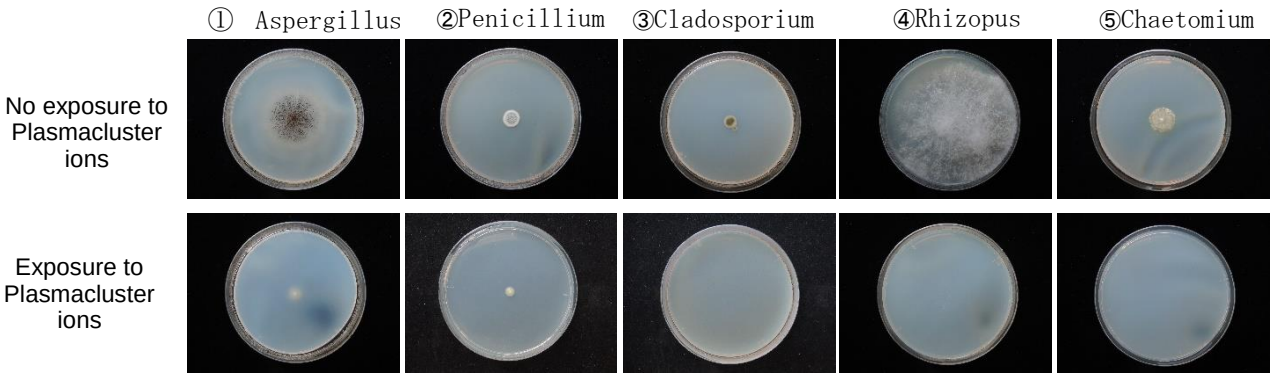
(1) Verification of inhibitory effect on germination and growth of spores

As can be seen from the table below, the test proved that Plasmacluster ions are effective in reducing at least 99.9% of the mold spores of the five types of mold.

Fungus type	Initial fungus count	Number of colonies	Inhibition rate
① Aspergillus	4.64×10^5	Not detected	> 99.9%
② Penicillium	6.44×10^6	Not detected	>99.9%
③ Cladosporium	1.10×10^6	Not detected	> 99.9%
④ Rhizopus	1.50×10^6	8	99.9%
⑤ Chaetomium	4.24×10^4	Not detected	>99.9%

(2) Verification of inhibitory effect on mycelia growth and spore formation

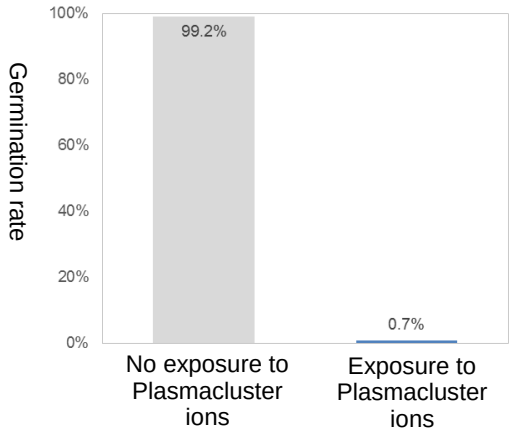
As can be seen from the photographs below, the test proved that, under exposure to Plasmacluster ions, although slight growth of mycelia could be seen inside the medium where the ions could not reach in some of the mold, growth was inhibited on the medium surface, colonies did not get larger, and spore formation was inhibited.



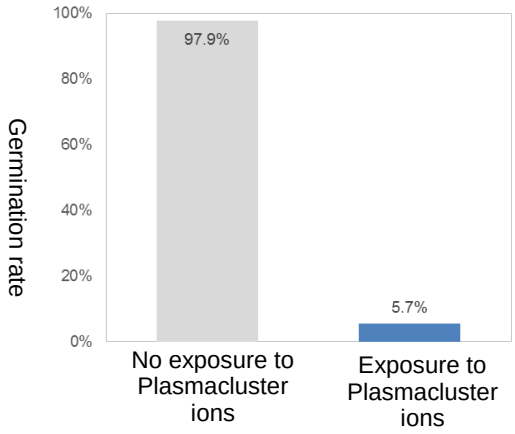
(3) Verification of inhibitory effect on fully formed spores
(only ① Aspergillus and ② Penicillium were tested)

As can be seen from the results below, the extracted Aspergillus and Penicillium spores that were exposed to Plasmacluster ions for three days had a dramatically smaller rise in germination rate after 12 hours of cultivation. Even the spores formed in the Aspergillus and Penicillium that had been sufficiently grown were shown to be inhibited by Plasmacluster ions.

① Aspergillus



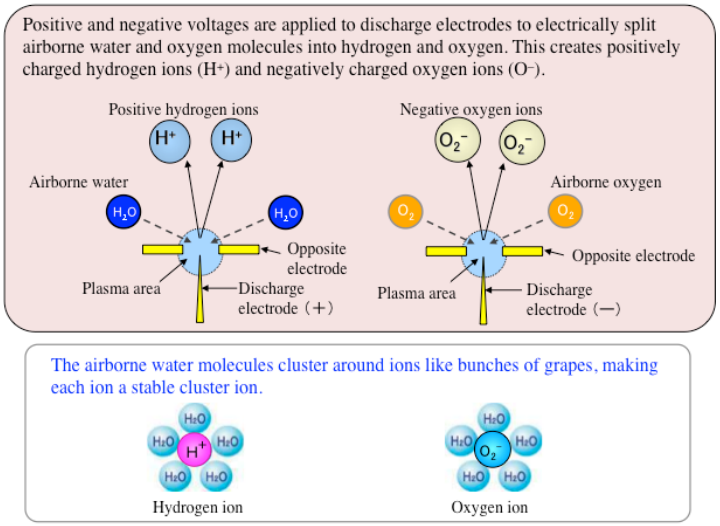
②Penicillium



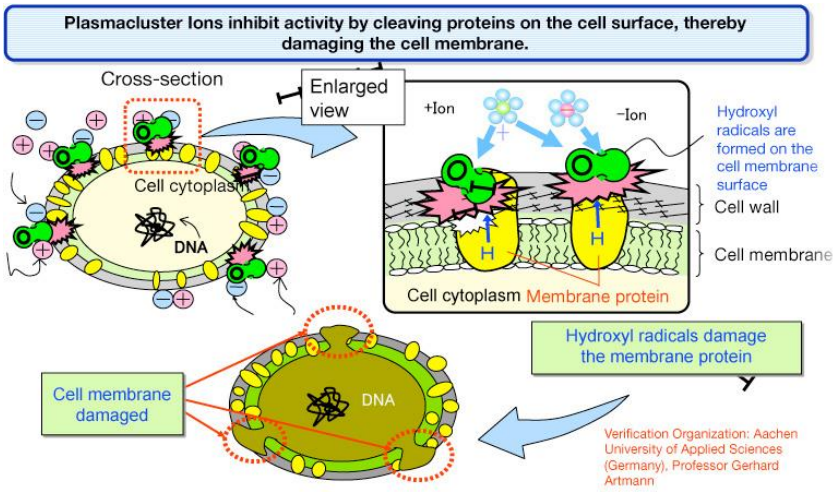
■About Plasmacluster Technology

In Sharp's proprietary air purification technology, positively charged hydrogen ions $(H^+ (H_2O)_n)$ and negatively charged oxygen ions $(O_2^- (H_2O)_m)$ are discharged simultaneously. These positive and negative ions instantaneously bond on the surface of airborne substances such as bacteria, fungi, viruses, and allergens, becoming highly reactive OH radicals (hydroxyl radicals) that break down the proteins on the surface of these bacteria and other substances. By chemical reaction, the OH radicals work to suppress the activity of those substances.

How Plasmacluster Ions Are Generated



Mechanism for Inhibiting the Activity of Airborne Bacteria



■ Comparison of Oxidation

Positive and negative ions bond on the surface of airborne viruses and bacteria and react chemically to form OH radicals, which have high oxidation power (standard oxidation potential 2.81 V). These reduce the contagiousness of airborne viruses and the activity of bacteria.

Active Substances	Chemical Formula	Standard Oxidation Potential (V)
Hydroxyl radicals	・OH	2.81
Oxygen atom	・O	2.42
Ozone	O_3	2.07
Hydrogen peroxide	H_2O_2	1.78
Hydroperoxyl radical	・OOH	1.7
Oxygen molecule	O_2	1.23

Source: *Fundamentals and Applications of Ozone*

■ **Research Institutes That Provided Data for Sharp's Academic Marketing**

Target	Testing and Verification Organization	Country
Efficacy proven in clinical trials	Graduate School of Medicine, University of Tokyo / Public Health Research Foundation	Japan
	Faculty of Science and Engineering, Chuo University / Clinical Research Support Center, University Hospital, University of Tokyo	Japan
	Animal Clinical Research Foundation	Japan
	Soiken Inc.	Japan
	School of Bioscience and Biotechnology, Tokyo University of Technology	Japan
	National Trust Co., Ltd. / HARG Treatment Center	Japan
	National Center of Tuberculosis and Lung Diseases	Georgia
Viruses	Kitasato Research Center of Environmental Sciences	Japan
	Seoul National University	Korea
	Shanghai Municipal Center for Disease Control and Prevention	China
	Kitasato Institute Medical Center Hospital	Japan
	Retroscreen Virology, Ltd.	UK
	Shokukanken Inc.	Japan
	University of Indonesia	Indonesia
	Hanoi College of Technology, Vietnam National University	Vietnam
	Institut Pasteur, Ho Chi Minh City	Vietnam
Allergens	Graduate School of Advanced Sciences of Matter, Hiroshima University	Japan
	Department of Biochemistry and Molecular Pathology, Graduate School of Medicine, Osaka City University	Japan
Fungi	Ishikawa Health Service Association	Japan
	University of Lübeck	Germany
	Professor Gerhard Artmann, Aachen University of Applied Sciences	Germany
	Japan Food Research Laboratories	Japan
	Shokukanken Inc.	Japan
	Shanghai Municipal Center for Disease Control and Prevention	China
	Biostir Inc.	Japan
Bacteria	Ishikawa Health Service Association	Japan
	Shanghai Municipal Center for Disease Control and Prevention	China
	Kitasato Research Center of Environmental Sciences	Japan
	Kitasato Institute Medical Center Hospital	Japan
	Dr. Melvin W. First, Professor Emeritus, Harvard School of Public Health	US
	Animal Clinical Research Foundation	Japan
	University of Lübeck	Germany
	Professor Gerhard Artmann, Aachen University of Applied Sciences	Germany
	Japan Food Research Laboratories	Japan
	Shokukanken Inc.	Japan
	Chest Disease Institute	Thailand
Odors, pet smells	Boken Quality Evaluation Institute	Japan
Skin beautifying effects	School of Bioscience and Biotechnology, Tokyo University of Technology	Japan
Hair beautifying effects	Saticine Medical Co., Ltd.	Japan
	C.T.C Japan Ltd.	Japan
Working mechanism of inhibitory effects on viruses, fungi, and bacteria	Professor Gerhard Artmann, Aachen University of Applied Sciences	Germany
Working mechanism of inhibitory effects on allergens	Graduate School of Advanced Sciences of Matter, Hiroshima University	Japan
Working mechanism of skin moisturizing (water molecule coating) effect	Research Institute of Electrical Communication, Tohoku University	Japan
Stress level and concentration level	Dentsu ScienceJam Inc.	Japan