

Demonstration of Plasmacluster technology's suppressive effect on athlete's foot fungus*¹

Under the supervision of Associate Professor Yaguchi of Medical Mycology Research Center, Chiba University, who is an expert in mold research, Sharp has demonstrated with mold testing equipment*² (Plasmacluster ion density: approx. 200,000 to 900,000 pcs/cm³) that Plasmacluster technology has an inhibitory effect on the two types of Trichophyton*³ which account for approximately 90% of athlete's foot infections in Japan, and that it has an inhibitory effect on hyphae as well as spores of fungi.

With one in five Japanese reportedly infected with athlete's foot*⁴, it is one of the most common infectious diseases. Many people get infected from bath mats in bathing rooms, and the number of infected people tends to increase as people get older. In recent years, the number of infections has also been increasing among young women who wear pumps and boots for long periods of time.

In 2018, we demonstrated the effectiveness of Plasmacluster in inhibiting the growth stages of five types of mold which account for approximately 80% of the mold that grows in general households*⁵. Now we have demonstrated its inhibitory effect on the spore and hyphal growth stages of Trichophyton.

Since 2000, Sharp has been conducting academic marketing*⁶ in which it works with many third party research institutions around the world. 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. At the same time, the safety of Plasmacluster technology has also been confirmed*⁸. Sharp will continue to contribute to society through various demonstrations of Plasmacluster technology.

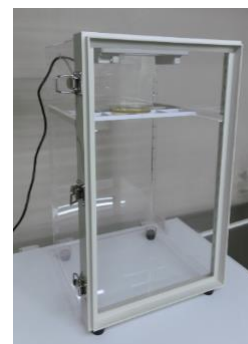
Comments from Yaguchi, Associate Professor, Medical Mycology Research Center, Chiba University
Athlete's foot is caused by a dermatophyte (mold) called Trichophyton infecting the stratum corneum of the skin. In the summer, wearing shoes for long periods of time causes them to become hot and humid inside, leading to the growth of Trichophyton and the symptoms of athlete's foot. It is said that virtually 100% of the places touched by bare feet in the home of a ringworm patient, such as the bathing room, contain Trichophyton, so to avoid infecting the family, such areas must be kept clean at all times. In real environments, Trichophyton is thought to exist in the stages of hyphae and spores. We have now confirmed that in addition to inhibiting the germination of Trichophyton spores, Plasmacluster technology also inhibits the elongation of hyphae, and it is expected that it may have an inhibitory effect in real environments.

- ※ 1 About Trichophyton. Athlete's foot is caused by Trichophyton (a type of mold), which infects the stratum corneum of the skin and proliferates.
- ※ 2 Verification device for acrylic container with internal dimensions of 285 × 275 × 485 mm.
- ※ 3 Tested with two types of Trichophyton; *Trichophyton rubrum* and *Trichophyton mentagrophytes*. From the 2011 Dermal Mycology Epidemiological Survey Report (Epidemiological Survey Committee of the Japanese Society for Medical Mycology).
- ※ 4 From the Dermatology Q&A on the Japanese Dermatological Association website.
- ※ 5 Announced March 8, 2018. Five types of mold used in JIS antimicrobial testing: (1) *Aspergillus niger*; Aspergillus, (2) *Penicillium citrinum*; Penicillium, (3) *Cladosporium cladosporioides*; Cladosporium, (4) *Rhizopus oryzae*; Rhizopus, (5) *Chaetomium globosum*; Chaetomium.
- ※ 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).

●Plasmacluster and the Plasmacluster logos are registered trademarks of Sharp Corporation

■ Overview of Verification Test

- Test laboratory: Chiba University's Medical Mycology Research Center
- Test space: Acrylic box with internal dimensions of 285 × 275 × 485 mm.
- Test device: Plasmacluster ion generator (Attached to the top inside of the box.)
- Plasmacluster Ion density: Approx. 200,000 to 900,000 pcs/cm³ in test container
- Control test: Comparison with the abovementioned device without ion generation
- Verification Trichophyton species: *Trichophyton rubrum*
Trichophyton mentagrophytes



Test device

● Test method

1. Efficacy tests on two types of Trichophyton.

A suspension of spores of the test organism was spread on a medium, irradiated with Plasmacluster ions in a verification device for 24 hours, then cultured for 3 to 4 days, and the number of colonies grown was counted. The distance between the ion generator and the medium was 12 cm. (Plasmacluster ion density: approx. 900,000 pcs/cm³)

2. Efficacy tests on “spore”: Evaluation of *Trichophyton rubrum* in the spore stage

A suspension of spores of the test organism was spread on a medium, irradiated with Plasmacluster ions in a verification device for 24 hours, then inhibitory effect on spore germination was observed using a microscope. The distance between the ion generator and the medium was 12 cm. (Plasmacluster ion density: approx. 900,000 pcs/cm³)

3. Efficacy tests on “hyphae”: Evaluation of *Trichophyton rubrum* in the hyphae stage

A suspension of spores of the test organism was spread on a medium, then cultured for 1 day, germination and hyphal elongation were confirmed. Thereafter, the inhibitory effect on hyphal elongation after 24 hours in a verification device with and without irradiation with Plasmacluster ions was observed using a microscope. The distance between the ion generator and the medium was 12 cm. (Plasmacluster ion density: approx. 900,000 pcs/cm³)

4. Test of Plasmacluster ion density-dependent effects (*Trichophyton rubrum*)

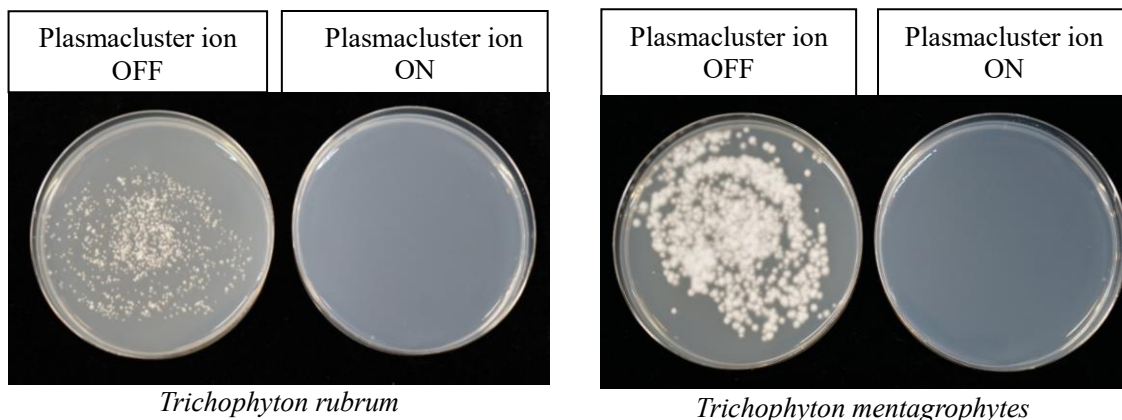
A suspension of spores of the test organism was spread on a medium, irradiated with Plasmacluster ions in a verification device for 3 hours, then cultured for 4 days, and the number of colonies grown was counted. The distance between the ion generator and the medium was 12 cm, 18 cm, and 24 cm (Plasmacluster ion density: approx. 900,000, 420,000, and 200,000 pcs/cm³, respectively)

● Result

1. Efficacy tests on two types of Trichophyton.

As shown in the table below, Plasmacluster ion has been proven to have an inhibitory effect of over 99.9% against two types of Trichophyton.

Trichophyton species	Plasmacluster ion OFF (number of colonies)	Plasmacluster ion ON (number of colonies)	Inhibition rate
① <i>Trichophyton rubrum</i>	1.28×10^3	Not detected	>99.9%
② <i>Trichophyton mentagrophytes</i>	1.67×10^3	Not detected	>99.9%



2. Efficacy tests on “spore”

Without ion irradiation, spores germinated, hyphae elongated, and there was overall expansion compared to the start of the test. However, when ion irradiation was applied, there were no major changes from the start of the test, and no spore germination was observed, indicating that spore germination was inhibited by Plasmacluster ions.

At the start of the test	Plasmacluster ion OFF	Plasmacluster ion ON
	Spores germination and hyphal elongation is observed	No spore germination observed

(magnification × 400)

3. Efficacy tests on “hyphae”

Without ion irradiation, considerable hyphal elongation can be observed compared to the start of the test. However, when ion irradiation was applied, since the length of the hyphae was almost the same as at the start of the test, indicating that hyphal elongation was suppressed. It was demonstrated that the higher the ion concentration of Plasmacluster ions, the greater the inhibitory effect on *Trichophyton*.

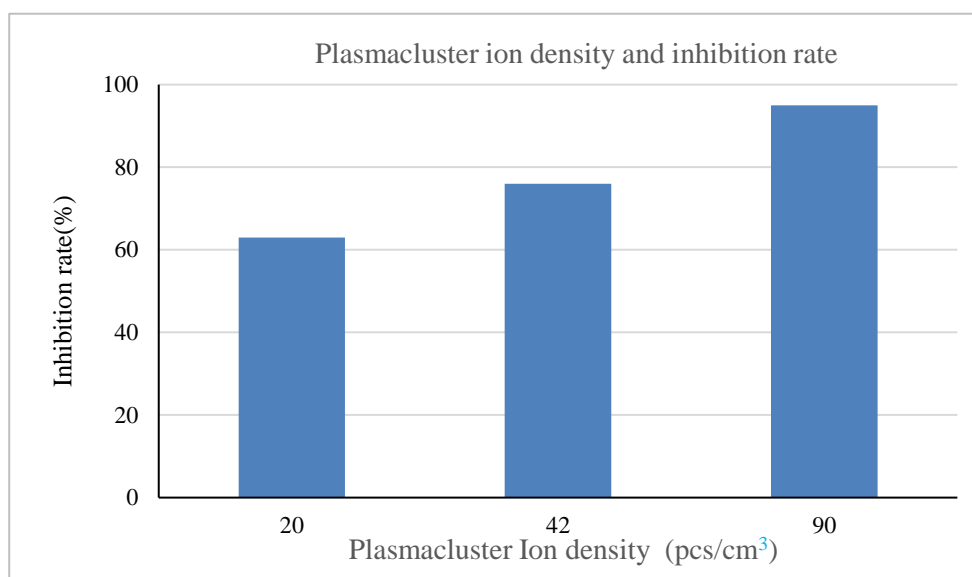
At the start of the test	Plasmacluster ion OFF	Plasmacluster ion ON
	Hyphae elongation is observed.	No hyphal elongation is observed.

(magnification × 400)

4. Test of Plasmacluster ion density -dependent effects

As shown below, we demonstrated that the higher Plasmacluster ion density, the more effective they are in suppressing Trichophyton.

Plasmacluster ion density (pcs/cm ³)	Plasmacluster ion OFF (number of colonies)	Plasmacluster ion ON (number of colonies)	Inhibition rate
200,000	600	225	63%
420,000		146	76%
900,000		28	95%



■Research Institutes That Provided Data for Sharp’s Academic Marketing

Target	Testing and Verification Organization
Fungi	Medical Mycology Research Center, Chiba University
	Ishikawa Health Service Association
	University of Lübeck, Germany
	Professor Gerhard Artmann, Aachen University of Applied Sciences, Germany
	Japan Food Research Laboratories
	Shokukanken Inc.
	Shanghai Municipal Center for Disease Control and Prevention, China
	Biostir Inc.
Viruses	Kitasato Research Center of Environmental Sciences
	Seoul National University
	Shanghai Municipal Center for Disease Control and Prevention, China
	Kitasato Institute Medical Center Hospital
	Retroscreen Virology, Ltd., UK
	Shokukanken Inc.
	University of 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
	Department of Biochemistry and Molecular Pathology, Graduate School of Medicine, Osaka City University
Efficacy proven in clinical trials	Graduate School of Medicine, University of Tokyo / Public Health Research Foundation
	Faculty of Science and Engineering, Chuo University / Clinical Research Support Center, University Hospital, University of Tokyo
	Animal Clinical Research Foundation
	Soiken Inc
	School of Bioscience and Biotechnology, Tokyo University of Technology
	National Trust Co., Ltd. / HARG Treatment Center
	National Center of Tuberculosis and Lung Diseases, Georgia

Bacteria	Ishikawa Health Service Association
	Shanghai Municipal Center for Disease Control and Prevention, China
	Kitasato Research Center of Environmental Sciences
	Kitasato Institute Medical Center Hospital
	Dr. Melvin W. First, Professor Emeritus, Harvard School of Public Health, US
	Animal Clinical Research Foundation
	University of Lübeck, Germany
	Professor Gerhard Artmann, Aachen University of Applied Sciences, Germany
	Japan Food Research Laboratories
	Shokukanken Inc.
	Chest Disease Institute, Thailand
	Biostr Inc.
Odors, pet smells	Boken Quality Evaluation Institute
Skin beautifying effects	School of Bioscience and Biotechnology, Tokyo University of Technology
Hair beautifying effects	Saticine Medical Co., Ltd.
	C.T.C Japan Ltd.
Stress level and concentration level	Dentsu ScienceJam Inc.
Working mechanism of inhibitory effects on viruses, fungi, and bacteria	Professor Gerhard Artmann, Aachen University of Applied Sciences
Working mechanism of inhibitory effects on allergens	Graduate School of Advanced Sciences of Matter, Hiroshima University
Working mechanism of skin moisturizing (water molecule coating) effect	Research Institute of Electrical Communication, Tohoku University