nanoseed performance test report

October 6, 2023

nanoseed

1267-1 Nakagome, Saku City, Nagano Pref. Japan
nanoseed Inc.

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Feb 9, 2021

Visualization Report of Space Sterilization by nanoseed α

−Visualization of Release / Diffusion of Fungicide with a Particle Size of 1 / 10,000 mm or less and Sterilization Effect−

February 8, 2021

Division of Mechanical Science and Technology
Faculty of Science and Technology
Gunma University

Professor Tsuneaki ISHIMA , Dr.Eng.

1-5-1 Tenjin-cho, Kiryu-shi, Gunma ,376-8515, Japan

1 Summary of this Report

As a result of preliminary experiments, it was found that the fungicide particles released from nanoseed α are "transparent", do not reflect the laser beam, and cannot be detected by a laser measuring instrument.
One way to visualize the movement of fungicide particles that are not reflected by the laser beam is to float fine smoke indoors and hit the particles against the smoke. When the particles collide, the smoke will move. By visualizing the movement of the smoke, we used a method of "indirectly" visualizing the movement of particles. It was visually confirmed that the nanoseed particles fly from nanoseed α to 2.7m high ceiling and to 7m away corner of the 165m² room . From these observations, it is confirmed that the particles from nanoseed α are flying to nearly every corner of 165m² room.

2 Purpose of Visualization of Spatial Sterilization

The results of space sterilization test conducted by Maebashi Institute of Technology, show that one sterilizer (nanoseed α) can be possible to sterilize in less than an hour even in a wide space of floor area 180 m² room (ceiling height 3 m×width15.5m×length11.6m) (Reference [1]). The purpose of this paper is to provide an indirect method to visualize invisible- transparent- particle- movements and is to give the physically academic evidence of the space sterilization effect of nanoseed α reported by Maebashi Institute of Technology.

3 Difficulty in Visualizing "Invisible Particles from nanoseed α"

The nanoseed α sprays a liquid to a room on the same principle as the generation of ionic wind. It has not been possible to specify the state of the liquid after spraying, such as particulate liquid, ionized or vaporized. Simple visualization shows that there are no fine droplets that are generated as ultrasonic humidifier. This indicates "transparent" fluid is emitted from nanoseed α. And then, the fluid does not reflect the laser beam, so it cannot be detected by a laser measuring device. The difficulty of visualization is due to the "transparency" of the particles.

4 An approach to visualize transparent invisible particles

In advance, fine smoke are kept floating in the room. If the released transparent particles hit the smoke, the smoke will be moved. The movement of smoke means that the particles from nanoseed α are flying to the smoke.

This paper tries to move smoke with the particles released by nanoseed α, and indirectly visualize the movement of the particles by the movement of smoke.

5 Experiment conditions for indirect visualization with smoke

(1) Sterizer : nanoseed α

Manufacturer: nanoseed Inc.
1267-1 Nakagomi, Saku , Nagano Prefecture 385-0051,Japan、
TEL +81-267-77-7652

Appearance : Fig. 1

Liquid used : A2Care solution (purified water 99.99%, sodium chlorite 0.01%)

Solution release : Continuous release of 1 mL release per minute

Fig.1 nanoseed α

Smoke solution : Product name "SAFEX" (made in the etherlands)
Manufacturer "Dantec Dynamics" (Denmark)

Smoke size : particle average size 1 μm = 0.001 mm (Reference [1]) Appearance Fig. 2

Fig. 2　Smoke generator

(3) Laser measuring device

Product name　:　Continuous Beam DPSS LASER

Model　:　Ray Power 2000

(4) Video recording camera for smoke movement

Product name　: High-Speed Video Camera

Model　:　Qlv

Manufacturer　:　nac Image Technology　(Japan)

(5) Video shooting conditions　: 250 frames per second

(6) Experiment place

Gunma University, Faculty of Science and Technology,

Project Building 304 Laboratory (width 7m×length7.7m×height2.7m)

(7) Speed analysis software

Product name　: Dynamic Studio

Manufacturer　: Dantec Dynamics (Denmark)

6　The flow of nanoseed particles visualized by smoke-movement

Fig.3 and Fig.4 show the flows of nanoseed particles visualized by smoke-movement. These flows are the flows of the smoke moved by particles released from nanoseed α

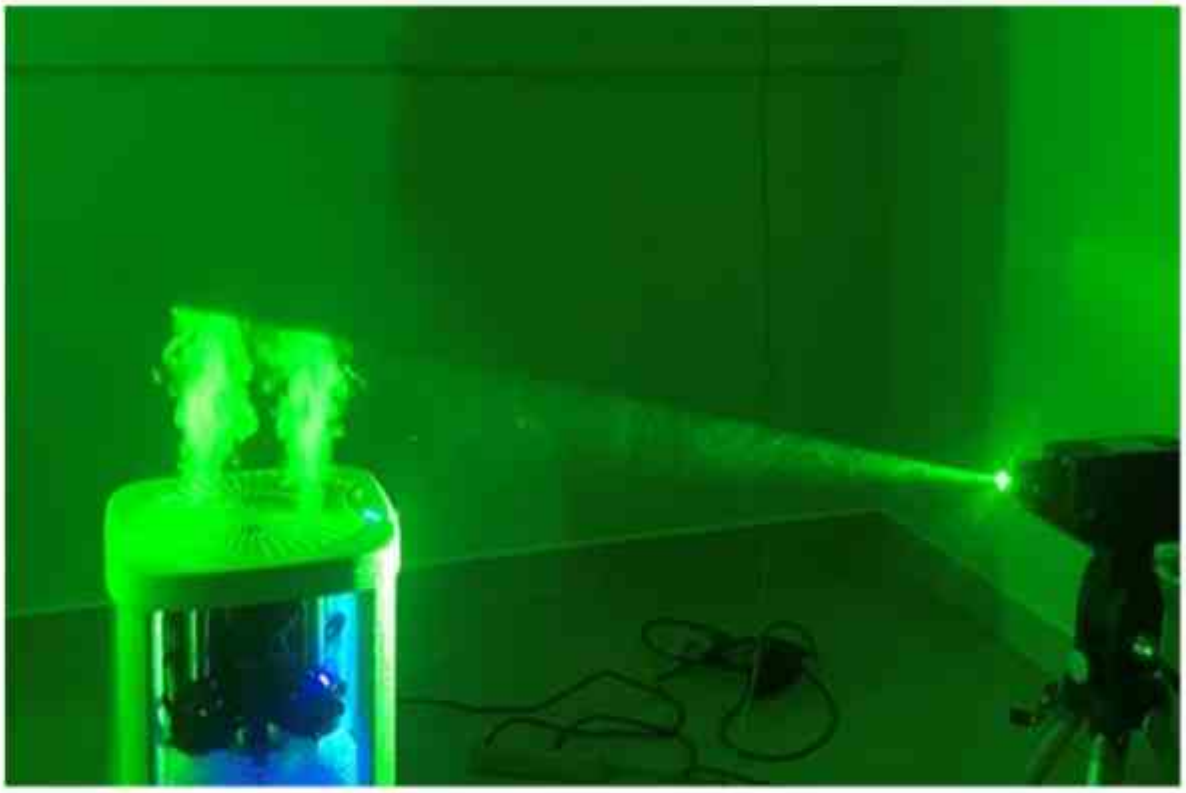


Fig. 3 Flow of smoke moved by Nanoseed particles (Part 1)

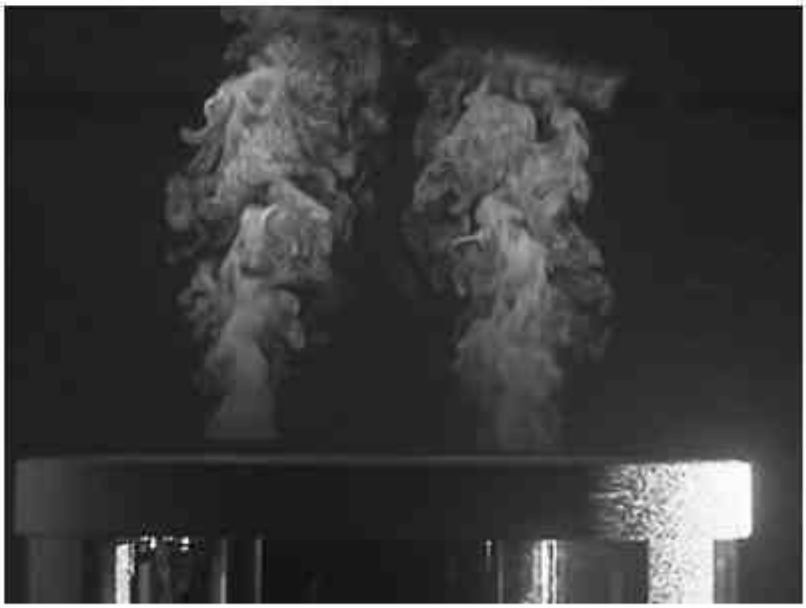


Fig. 4　Flow of smoke moved by nanoseed particles (Part 2)

The video is uploaded to the following address.
https://nanoseed.jp/mvg/

7 Flying range of particles released from nanoseed α

Smoke is moving just in front of the chip of the camera in Figure 3. Since the distance between the nanoseed α and the camera is 1.5 m, it can be seen that the nanoseed particles are flying at least 1.5 m.
Smoke was visually confirmed to fly from nanoseed α to 2.7m high ceiling of the room ,and to 7m away corner of the room.
These observations show that the particles from nanoseed α are flying to the corner of 165m^2 room (Note 1).

(Note 1) Assuming that nanoseed α is placed in the center of floor area 165m^2 room and the room is a regular quadrangle, the distance ℓ from the center of the room to the corner of the room is,

$$\ell = \sqrt{(12.85/2)^2 + (12.85/2)^2} \fallingdotseq \sqrt{(41+41)} = \sqrt{82} \fallingdotseq 9\text{m}$$

If the particles are flying up to 10m, it can be said that they are flying to nearly every corner of the 165m^2 room.

8 Velocity of Released Particles

Fig.4 and Fig. 5 shows "the vertical velocity distribution map" of the released particles.
The colors in Fig. 4 and Fig.5 indicate the "particle-speed-range". The "yellow" indicates the range of speed from 0.30m/s to 0.325m/s.
The colors of Fig.4 and Fig.5 show that the speeds of released particles are in the range of 0.175m/s～0.500m/ s . From these colors, it can be said that the average speed of particles is 0.35m/s.
That is to say, it can be said that the released particles flies about 35 cm per second.
Fig. 5 shows that the flow of particles is not only a vertical flow but also an obliquely upward direction, resulting in a complicated flow.

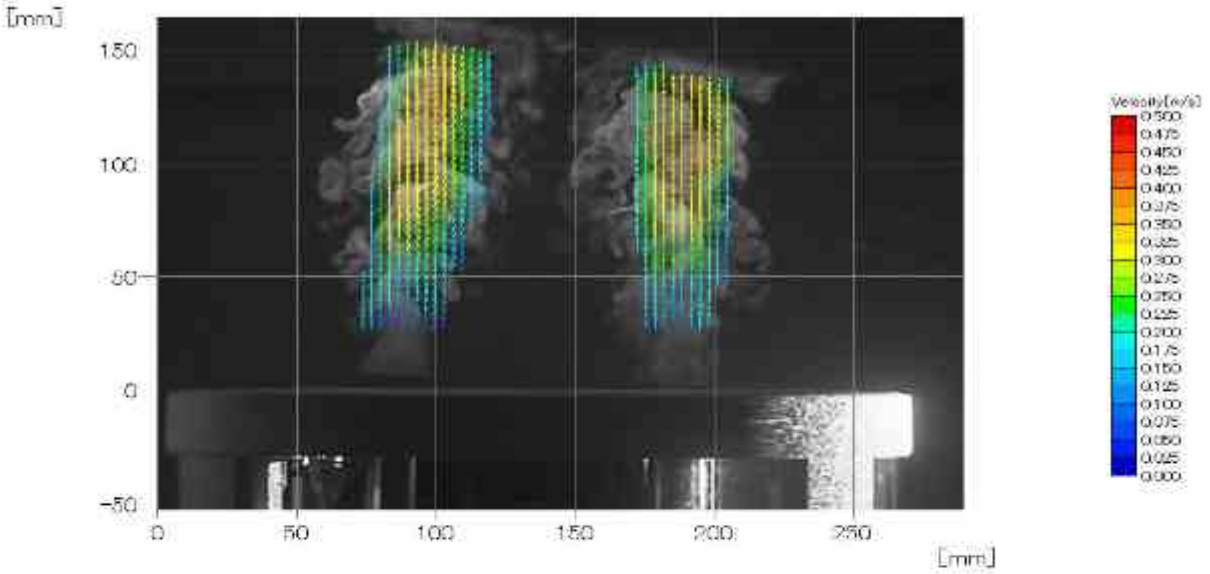


Fig. 5 Vertical velocity of Released Particles (color indicates velocity)

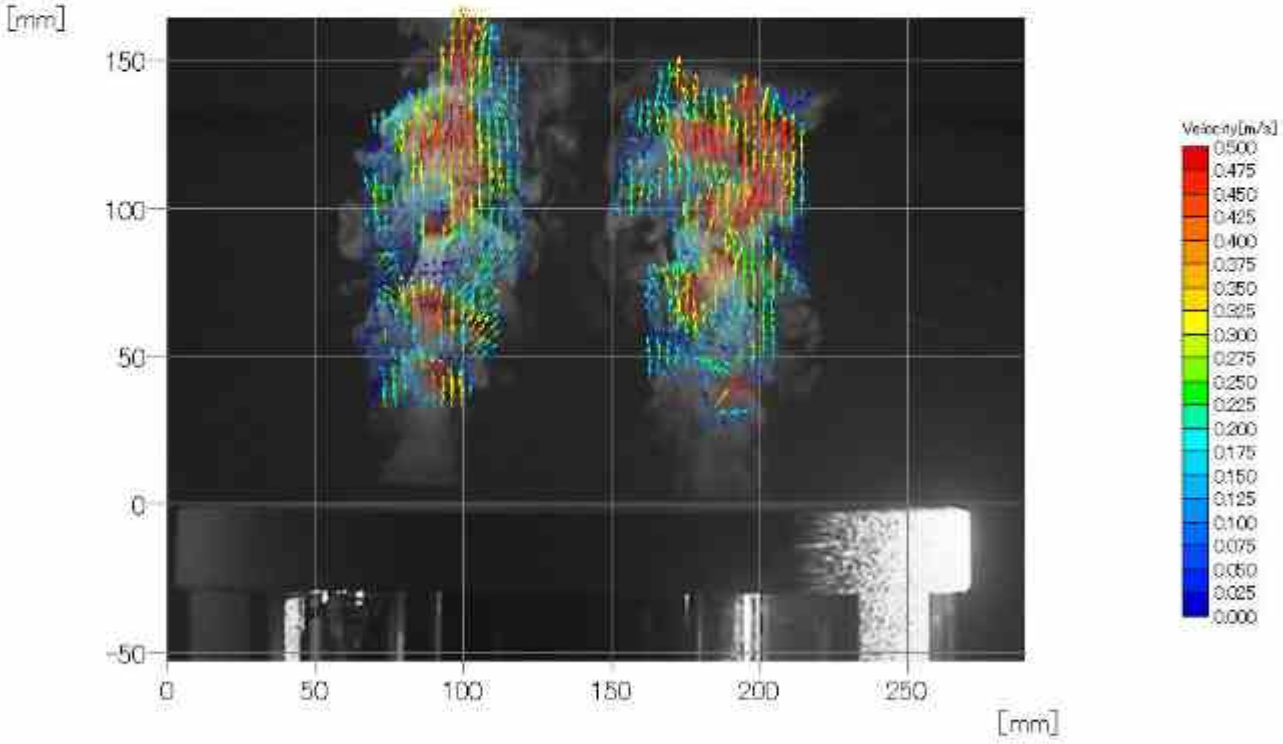


Fig. 6 Direction and Verocity of Flow (color indicates velocity)

9 The Effect of Sterilization by "Particle Speed" and " Flying Distance"

According to a theoretical analysis at Maebashi Institute of Technology (p.8 of Reference [2]), the particles of nanoseed α are much smaller than the spray of an "ultrasonic humidifier", so the speed of the particles is fast and they can fly far., has been theoretically elucidated. We believe that this research was able to demonstrate the analysis results at Maebashi Institute of Technology.
As the speed of the particles increases, the rate at which the particles collide with the bacteria increases, so the sterilization effect increases and the flight distance increases, which is thought to have made it possible to sterilize in a wide space of floor area 165m^2.

10 Conclusion

When the particles collide, the smoke will move. By visualizing the movement of the smoke, we used a method of "indirectly" visualizing the movement of particles. It was visually confirmed that the nanoseed particles fly from nanoseed α to 2.7m high ceiling and to 7m away corner of the room. From these observations, it is confirmed that the particles from nanoseed α are flying to nearly every corner of 165m^2 room.

11 Acknowledgments

Dr. Shuhei Yoshino, a professor at Maebashi Institute of Technology, who conducted the sterilization test [2], provided information on the types and characteristics of microorganisms. Dr. Yukio Shimoda, a visiting professor at Maebashi Institute of Technology, provided advice on summarizing this research. We would like to thank both doctors.

12 References

[1] Technical Information,「SAFEX」、Nebel Fluid Exctra Clean F&D, 2011/2020、vol.19、No.01、2020

[2] Shuhei Zenno,「Test Report on Space Sterilization by nanoseed α－Sterilization Effect of nanoseed α in 180m^2 Room」, Maebashi Institute of Technology of Engineering, Public University Corporation, December 26,2020

Results of sterilization and deodorization test using nanoseed α with nanoseed ionized water

nanoseed Inc.

May 25, 2023

〈Space sterilization test〉

Test site：Testing room (W 1.8 m × D 3.6 m × H 1.8 m, volume 12.2 m³)

Device：nanoseed α

Functional water：nanoseed ionized water (cleanseed)

Testing method： First, before conducting the test, E. coli, Bacillus subtilis, and yeast were allowed to grow in an aerated liquid culture indoors for 30 minutes to produce airborne bacteria. Next, after 0, 1, and 2 hours of running nanoseed α, the sterilization device was shut off, and then the air sampler was used to aspirate room air to collect the airborne bacteria on agar medium. The collected medium was incubated at room temperature, and the number of colonies formed was visually measured. As a comparison, a similar collection of suspended bacteria was also performed under conditions in which the device was not in operation.

test results：

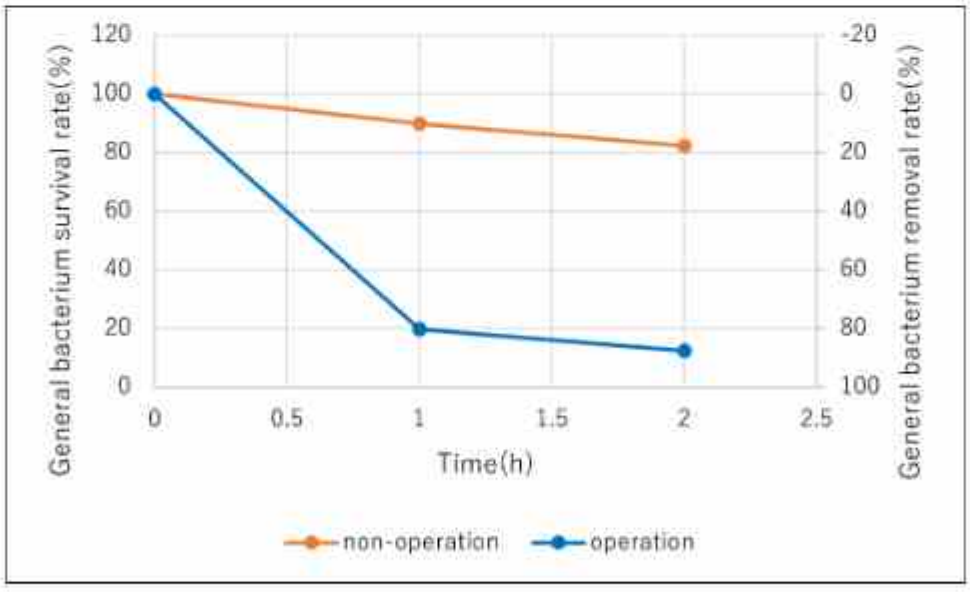


Figure 1　Sterilization effect on general bacteria

The sterilization rate was 17% when the device was not in operation and 87% when the device was in operation over a 2-hour period.

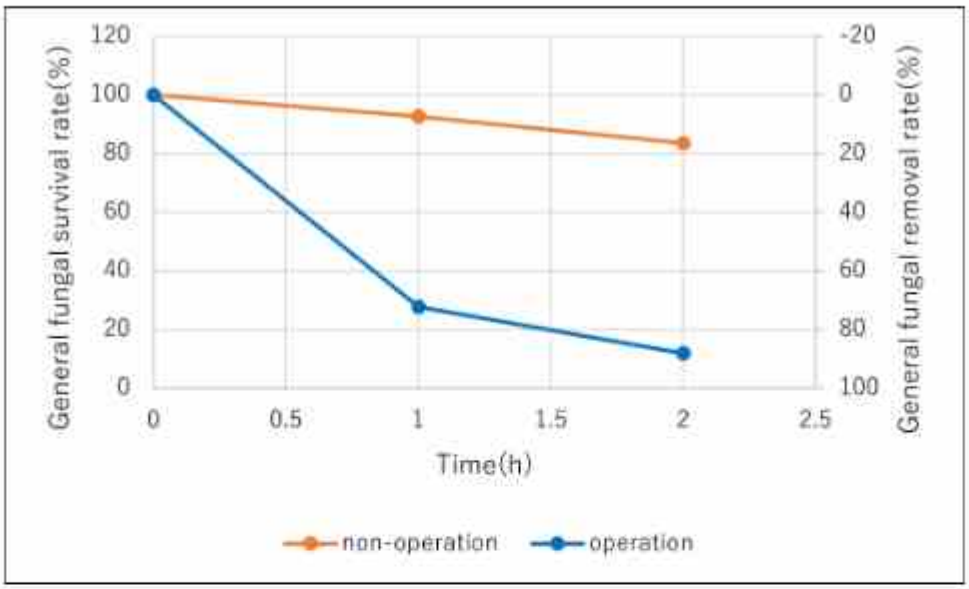


Figure 2　Sterilization effect on general fungi

The sterilization rate was 16% when the device was not in operation and 88% when the device was in operation over a 2-hour period.

When the nanoseed α was operated with ionized water, more than 80% of both general bacteria and general fungi were sterilized in 2 hours. In addition, there was a clear difference in sterilization effectiveness compared to the case in which no operation was performed.

〈Deodorant test〉

Test site：Glass case (W 1.0 m × D 1.0 m × H 1.0 m, volume 1.0 m^3)

Device：nanoseed α

Functional water：nanoseed ionized water (cleanseed)

Tested for：ammonia, acetic acid, formaldehyde

Testing method：First, before conducting the test, the odorant substance was placed in a petri dish in a glass case to diffuse the odorant substance. Next, the nanoseed α was operated and the concentration of the odorant substance was measured every 10 minutes. As a comparison, similar tests were also conducted under conditions in which the device was not operation.

test results：

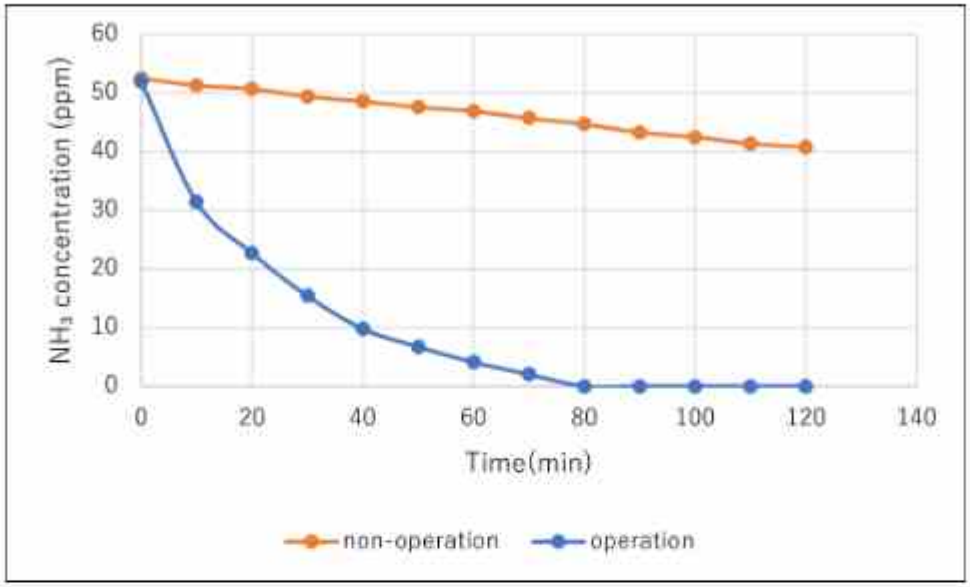


Figure 3　Deodorant effect on ammonia

The deodorization rate was 14% when the device was not in operation and 100% when the device was in operation at 80 minutes.

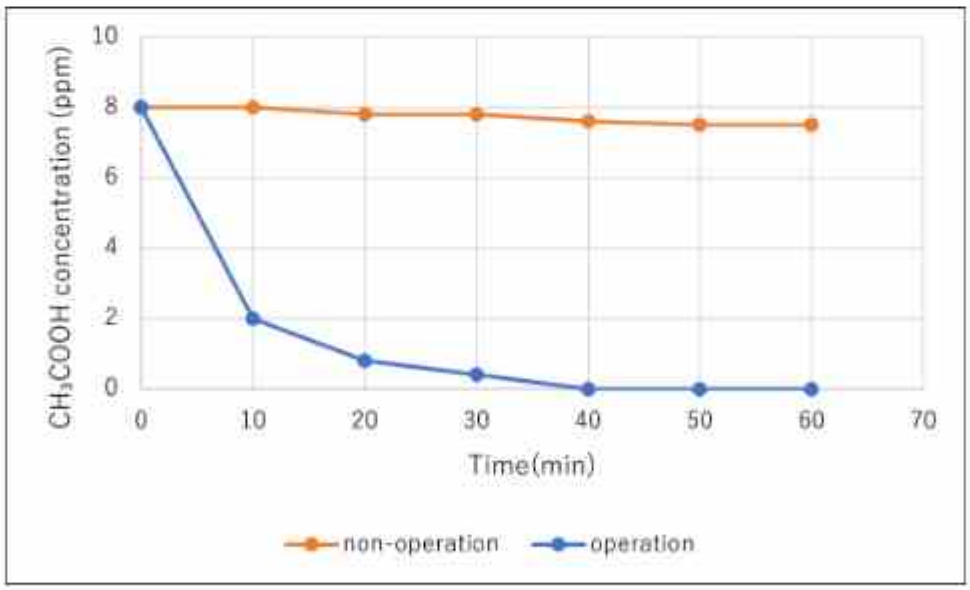


Figure 4　Deodorant effect on acetic acid

The deodorization rate was 5% when the device was not in operation and 100% when the device was in operation at 40 minutes.

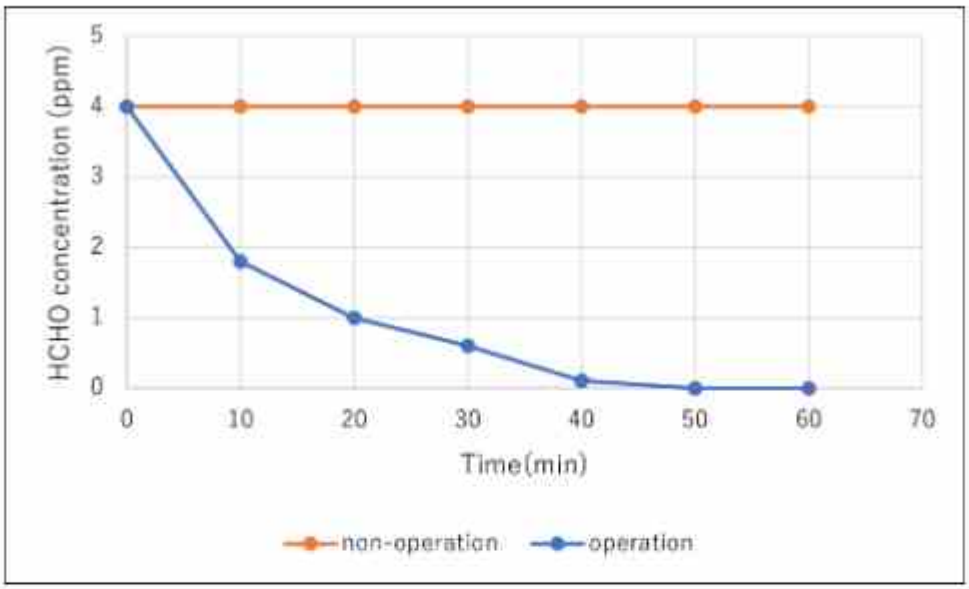


Figure 5 Deodorant effect on formaldehyde

The deodorization rate was 0% when the device was not in operation and 100% when the device was in operation at 50 minutes.

When the nanoseed α was operated with ionized water, it was found to be effective in deodorizing ammonia, acetic acid, and formaldehyde. The time required for deodorization depends on the concentration of the target substance.

Sterilization test against falling bacteria using nanoseed ionized water (cleanseed)

nanoseed inc.

October 2, 2023

Test site：Glass case (W 1.0 m ×D 1.0 m ×H 1.0 m, volume 1.0 m^3)

Device：nanoseed M

Functional water：nanoseed ionized water (cleanseed)

Testing method：First, the inside of the glass case was partitioned in half, with one side operating nanoseed M and the other side not (Figure 1). Next, six sheets of nutrient medium in petri dishes were prepared, and three sheets each were placed in a glass case with the lid of the petri dish open. The medium was left in that state and the growth of fallen bacteria was observed with photographic documentation of each time elapsed. To prevent the medium from drying out, an ultrasonic humidifier was used to keep the humidity in the glass case high before the start of the test.

Figure 1　Experiment situation

Test results：

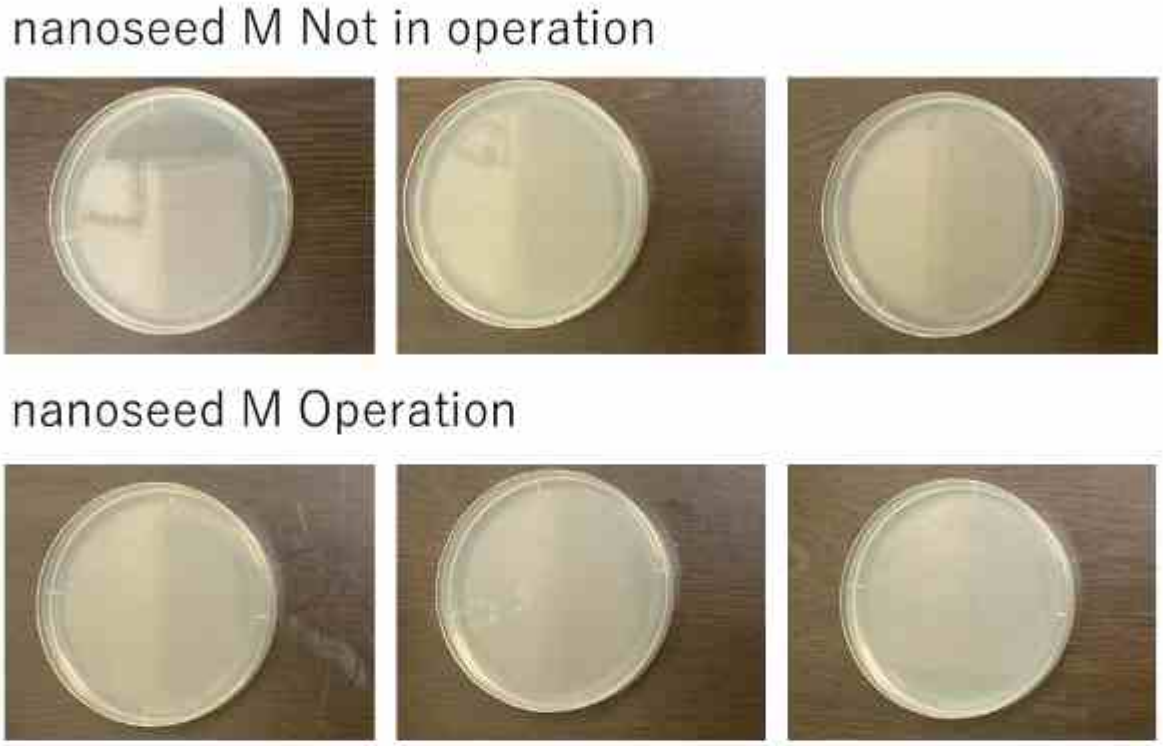


Figure 2　Culture medium after one day

Figure 3　Culture medium after two days

Figure 4　Culture medium after three days

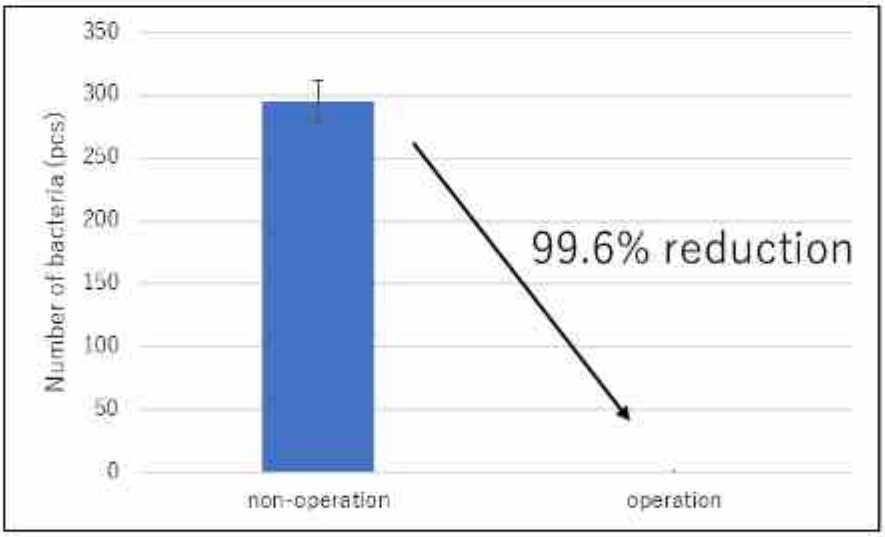


Figure 5　Difference in the number of bacteria in the culture medium after three days

In this study, when the nanoseed ionized water was used to test the sterilization of falling bacteria, there was a difference in the degree of growth of the bacteria in the culture medium with and without the device in operation. As can be seen from Figure 5, it was found that 99% of the growth of the falling bacteria could be inhibited by operating nanoseed M in a space of 0.5 m^3.

Growth inhibition test against fungi using nanoseed ionized water (cleanseed)

nanoseed inc.

October 3, 2023

Test site：Glass case (W 1.0 m ×D 1.0 m ×H 1.0 m, volume 1.0 m^3)

Device：nanoseed M

Functional water：nanoseed ionized water (cleanseed)

Testing method：The fungus used in this study was identified as *Trichoderma Virens*. First, the inside of the glass case was partitioned in half, with one side operating nanoseed M and the other side not (Figure 1). Next, six sheets of nutrient medium in petri dishes with fungi inoculated in the center were prepared, and three sheets each were placed in a glass case with the lid of the petri dish open. The medium was left in that state and the growth of fungi was observed with photographic documentation of each time elapsed. To prevent the medium from drying out, an ultrasonic humidifier was used to keep the humidity in the glass case high before the start of the test.

Figure 1　Growth inhibition test against fungi

Test results：

nanoseed M Not in operation

nanoseed M Operation

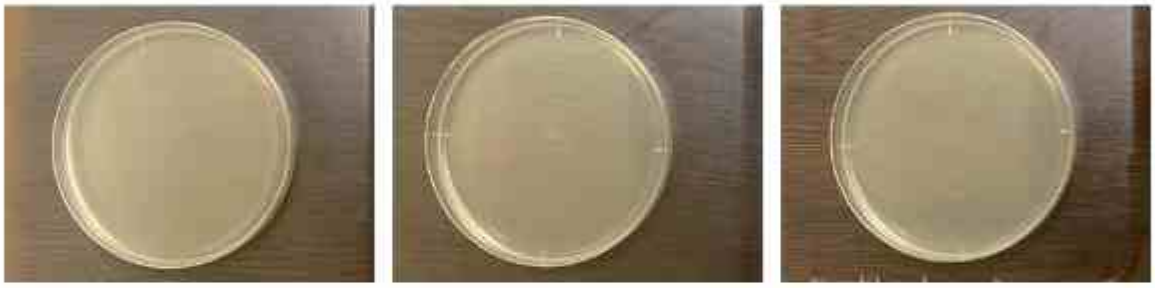


Figure 2　Photographs of *T. Virens* over time (1 day elapsed)

nanoseed M Not in operation

nanoseed M Operation

Figure 3　Photographs of *T. Virens* over time (2 days elapsed)

Figure 4　Photographs of *T. Virens* over time (3 days elapsed)

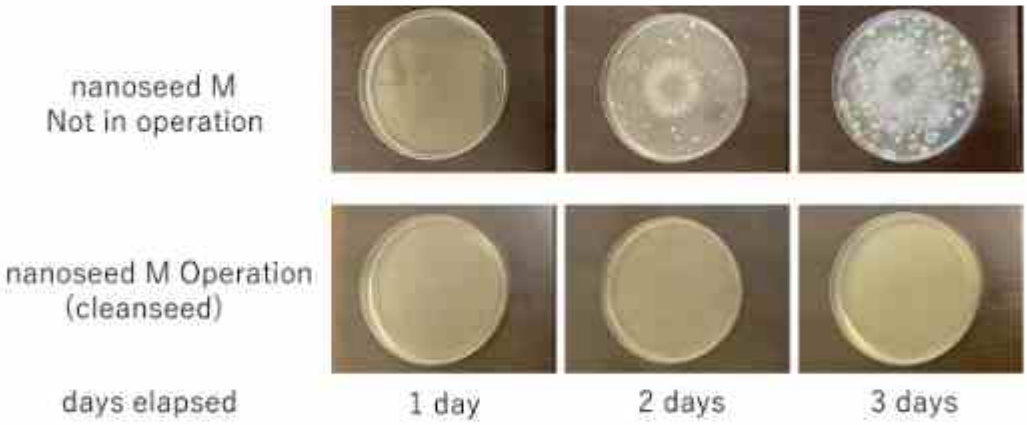


Figure 5　Photographs of *T. Virens* over time

When nanoseed M was operated in the glass case, T. Virens was seen to spread from the center, but only on the surface of the medium, and no spore-like material was seen. In the nanoseed M not in operation, spore-like material was observed to spread and color over time. Differences were also observed in the degree of adhesion of airborne bacteria.

This suggests that operating the device with cleanseed as functional water has an inhibitory effect on the growth of fungi.

Growth inhibition test against *Bacillus subtilis natto* using nanoseed ionized water (cleanseed)

nanoseed Inc.

October 20, 2023

Test site：Glass case (W 1.0 m ×D 1.0 m ×H 1.0 m, volume 1.0 m^3)

Device：nanoseed M

Functional water：nanoseed ionized water (cleanseed)

Testing Method：*Bacillus subtilis natto* (Miyagino strain) was used in this study. First, the inside of the glass case was partitioned in half, with one side operating nanoseed M and the other side not (Figure 1). Next, eight sheets of nutrient medium applied with *B. subtilis natto* were prepared, and four sheets each were placed in a glass case with the lid of the petri dish open (the *B. subtilis natto* applied to the medium was at a different concentration in each of them). The medium was left in that state and the growth of *B. subtilis natto* was observed with photographic documentation of each time elapsed. To prevent the medium from drying out, an ultrasonic humidifier was used to keep the humidity in the glass case high before the start of the test.

Figure 1　Experiment situation

Test results：

nanoseed M Not in operation

nanoseed M Operation

Figure 2　Medium after 1 day (from left to right, in order of increasing concentration)

nanoseed M Not in operation

nanoseed M Operation

Figure 3　Medium after 2 day (from left to right, in order of increasing concentration)

On the side without nanoseed M operation, growth of *B. subtilis natto* colonies was observed. On the other hand, no *B. subtilis natto* colony growth was observed on the side with nanoseed M operation. This suggests that the use of cleanseed with nanoseed M has an inhibitory effect on the growth of *B. subtilis natto*.

For the side with nanoseeded M operation, a picture of the medium left at room temperature with the lid of the petri dish closed for 3 days after the test is shown below.

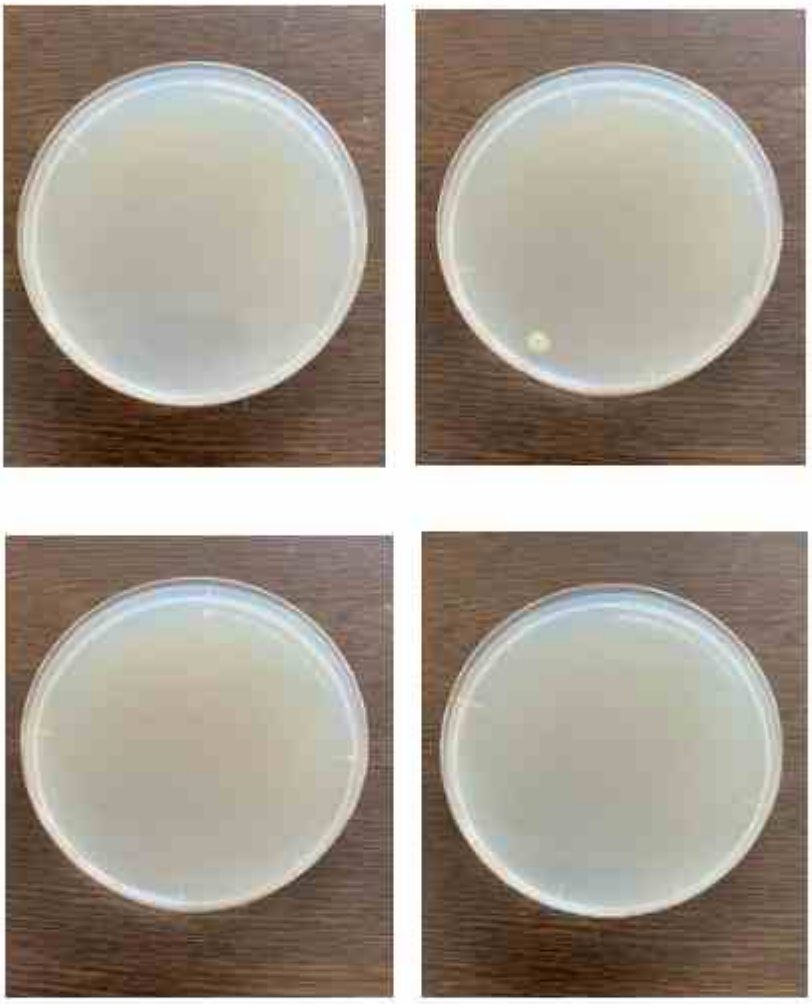


Figure 4　Medium after 3 days of testing on the side with nanoseeded M operation

From Figure 4, no growth of *B. subtilis natto* was observed in the medium even after the test was left at room temperature for three days. Therefore, it is considered that the growth of *B. subtilis natto* was completely inhibited in the space where the device was operated.

Also, one colony can be seen in the upper right photo in Figure 4, but it is unlikely to be *B. subtilis natto* from its appearance. It is thought to be bacteria from the atmosphere that entered after the test.

Inactivation test against cedar pollen allergen Cry j 1 using nanoseed α

nanoseed Inc.

July 18, 2023

Test site： Glass case (1.0 m wide × 1.0 m long × 1.0 m high, volume 1.0 m^3)

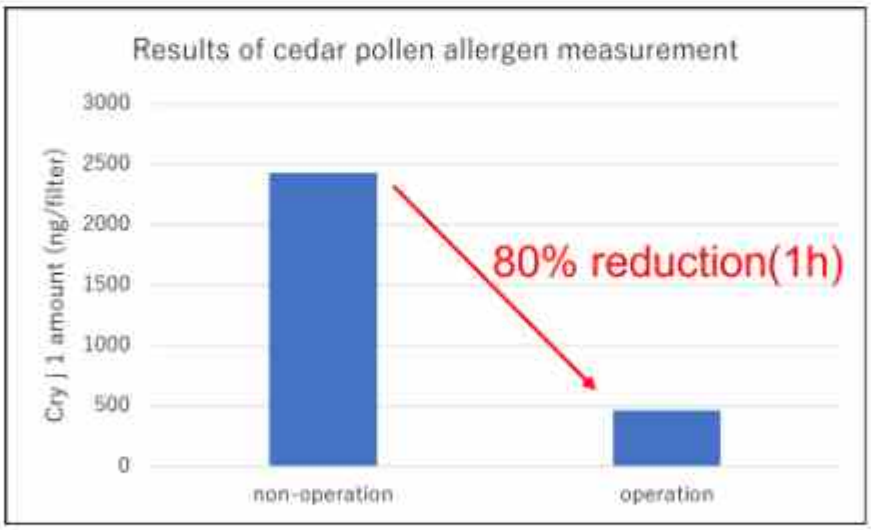
Device： nanoseed α

Functional water： nanoseed ionized water (cleanseed)

Testing method： Cedar pollen purchased from the Yamizo Pollen Research Association was used in this study. First, cedar pollen was placed on a non-woven filter. Next, the filter was placed in a glass case and the nanoseed α was operated for 1 hour in a nearly sealed condition. As a comparison, the same test was conducted under conditions in which nanoseed α was not operated. The collected filters were sent to Environmental Allergens Info and Care, Inc., which measures allergens in pollen, and asked to measure the amount of Cry j 1, a major allergen in cedar pollen.

※ Cry j 1 is one of the major allergens of Japanese cedar (Cryptomeria japonica) pollen.

Test Result：



Pollen testing using the device (nanoseed Inc.)

Allergen measurement (Environmental Allergens Info and Care, Inc.)

It was found that one hour of operation of nanoseed α resulted in 80% inactivation of Cry j 1, a major allergen of cedar pollen. This is thought to be due to the effect of active gases and various radicals generated by the operation of nanoseed α.

Deodorant test for perfume using nanoseed α

nanoseed inc.
August 18, 2023

Test site：Glass case (W 1.0 m × D 1.0 m × H 1.0 m, volume 1.0 m^3)

Device：nanoseed α

Functional water：nanoseed ionized water (cleanseed)

Testing method： Hermes perfume was used for this study. First, one push of perfume was sprayed on the kimwipes. Next, the kimwipes were placed on petri dish and left in a glass case for 1 minute to diffuse the odor components. The kimwipes were then removed from the glass case and the nanoseed α was operated in a nearly sealed condition to measure odor intensity over time. The air in the glass case was constantly stirred by a circulator. A portable odor sensor (XP-329m) from NEW COSMOS ELECTRIC CO., LTD. was used to measure odor intensity.

Test Result：

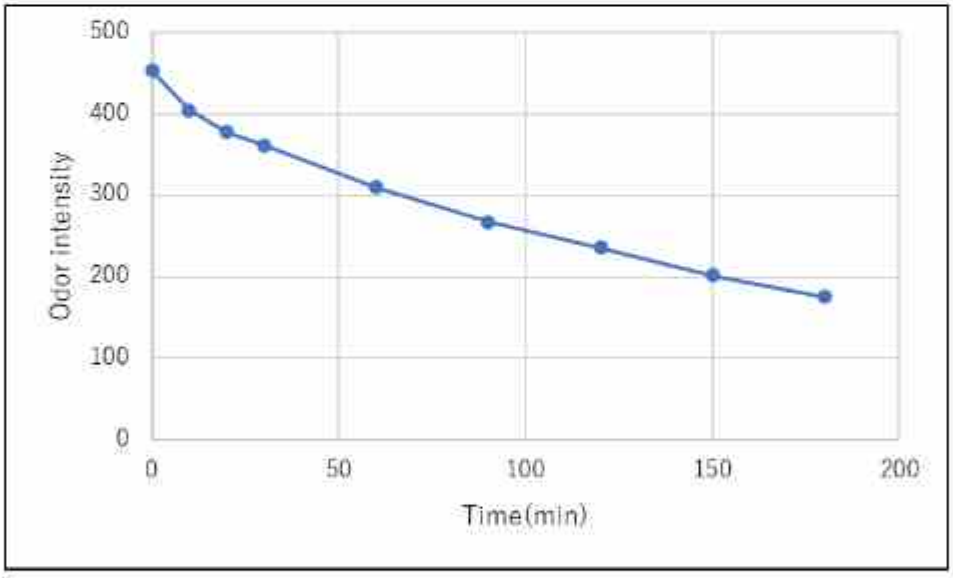


Figure 1 Deodorant effect on perfume

By operating nanoseed α, we were able to reduce the odor components in the perfumes used in this study. This is thought to be due to the decomposition or reaction of odor components by the effects of active gases and various radicals generated by the operation of nanoseed α.

The effectiveness of deodorization (e.g., the time it takes) is considered to depend on the concentration of odor components and the size of the space in which it is used.