

● New Anti-allergen Agent AlleRemove™

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1. Introduction

In recent years, the number of people suffering from allergic diseases such as hay fever caused by cedar pollen, allergic rhinitis caused by house dust ascribed to mites, and atopic dermatitis has increased rapidly and become a serious problem. When allergens, the substances that cause allergic symptoms, enter the body, they usually react with antibodies against the allergen, causing mast cells to release histamine, which in turn causes itching and inflammation. Although anti-allergic agents and topical steroids have been developed to treat these diseases, they are only symptomatic and not curative. Therefore, in order to reduce the symptoms of allergic diseases or to reduce new sensitization, the allergens must be removed from the living space before they are inhaled into the human body, or denatured and rendered harmless. This article introduces AlleRemove ZTP-170, a new type of anti-allergen agent we have developed to address this issue (Fig. 1).

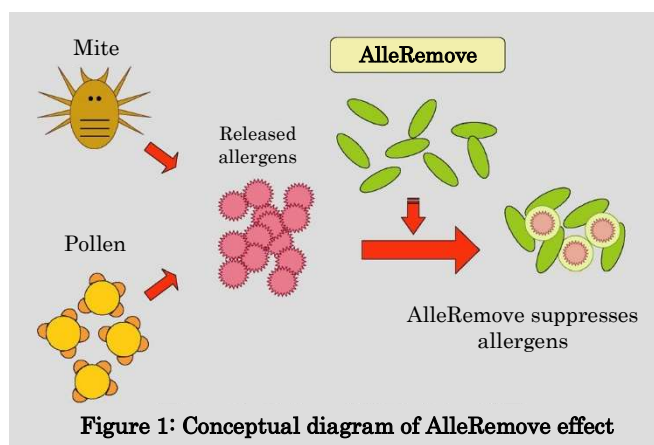


Figure 1: Conceptual diagram of AlleRemove effect

2. Current status of allergen removal

Allergens that cause allergic symptoms in humans include body hair and epithelium of dogs, cats, and birds; pollen from cedar, cypress, ragweed, and other plants; and animal and plant proteins from molds, mites, cockroaches, and their droppings. Allergic reactions are triggered in humans or animals through skin or mucous-membrane contact with these allergens.

For example, while mites in house dust are generally exterminated with acaricides, *Dermatophagoides farinae* and *Dermatophagoides pteronyssinus* in house dust trigger allergic reactions not only through their bodies but also through their feces and carcasses. Therefore, killing mites alone does not mean that the allergen has been inactivated, because even after death, the mite bodies gradually release minute allergens at the protein level as they decompose.

The current method of allergen removal in ordinary homes is to reduce allergens by physically removing floor deposits and airborne dust through suction with vacuum cleaners and air purifiers. However, large amounts of allergens suctioned by vacuum cleaners are likely to be re-scattered at disposal, and it is difficult for air purifiers to remove microscopic allergenic substances.

Therefore, in recent years, anti-allergen agents to inactivate and detoxify harmful allergens through adsorption or coating have been proposed. Examples of such agents include tannic acid¹⁾²⁾ and tea extracts containing analogous compounds, and polyphenols such as gallic acid³⁾⁴⁾. However, when only an organic anti-allergen agent such as tannic acid is applied to textile products, exposure to moisture, oil, or solvents, or if washed during laundering, the agent can be washed out, resulting in a loss of allergen-adsorption performance, or in coloring and discoloration of the textile. In addition, most inorganic anti-allergen agents are physical adsorbents based on zeolites or other materials. Although they offer excellent heat and water resistance, their allergen-inactivation performance is generally low (Table 1). Therefore, we developed a new anti-allergen agent that eliminates these disadvantages.

Table 1: Anti-allergen activity (allergen inactivation rate %) of various zeolites

Allergen	Zeolite A	Zeolite X	Zeolite ZSM-5
Mite allergen (Derf II)	35	34	12

* Evaluation by ELISA method

* Allergen inactivation rate when 500 μ L of 40 ng/mL Derf II was added to 10 mg of Zeolite

3. Characteristics of the new anti-allergen agent AlleRemove ZTP-170

“AlleRemove ZTP-170” is an organic/inorganic composite of a new concept that uses an inorganic material as the base. It is a highly safe new anti-allergen agent that compensates for the disadvantages of both organic and inorganic materials and has the advantages of high allergen inactivation performance, high water resistance, and resistance to discoloration.

3.1 Anti-allergen activity

ZTP-170 inactivates allergens powerfully even in small quantities through two distinct mechanisms: inactivation by the inorganic material itself, and inactivation by a polyphenol-based organic component.

Allergen proteins typically contain hydrophilic regions, hydrophobic regions, or charged regions. ZTP-170 is designed so that the anti-allergen agent can interact with these biorecognition sites.

Table 2 shows the results of evaluating the anti-allergen activity of ZTP-170 using the sandwich ELISA method (Enzyme-Linked Immunosorbent Assay) with *Dermatophagoides farinae* mite body allergen (Derf II), which is highly allergenic among house dust components, and cedar pollen allergen (Cryj1), as representative allergens. These results show the allergen inactivation rates calculated by deriving the residual allergen amount using the ELISA method after adding buffer solution of each allergen (500 μ L of 40 ng/mL Derf II and 500 μ L of 10 ng/mL Cryj1) to 1 mg of ZTP-170 powder and incubating for 1 hour. The inactivation rate exceeded 99% for both allergens.

Table 2: Anti-allergen activity of ZTP-170

Allergen	Cedar pollen (Cryj1)	Mite (Derf II)
Inactivation rate (%)	>99	>99

In addition, **Figures 2 and 3** show the results of calculating the allergen inactivation rate using the ELISA method after adding each allergen buffer solution (500 μ L of 40 ng/mL Derf II and 500 μ L of 10 ng/mL Cryj1) to 10 cm² of cloth made of 1/1 cotton/acrylic fiber and incubating for 1 hour, using the same procedure as above. The cloth samples were coated with a ZTP-170 slurry containing an acrylic binder as a spreading agent, at ZTP-170 loadings of 1 g/m² and 2 g/m². As a result, cloth coated at 2 g/m² showed an allergen inactivation rate exceeding 99% for each of the allergens.

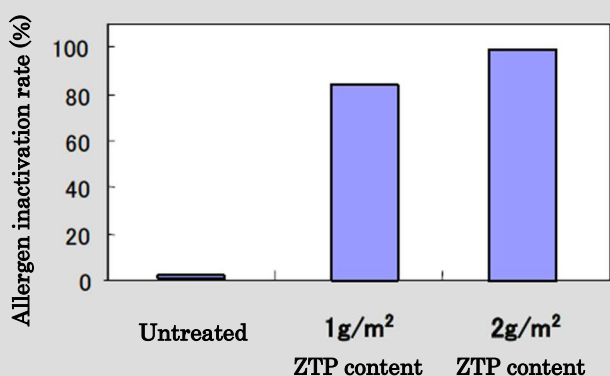


Figure 2: Activity against mite allergen (Derf II)

* Allergen inactivation rate = 100 × (initial amount of allergen - residual amount of allergen)/initial amount of allergen

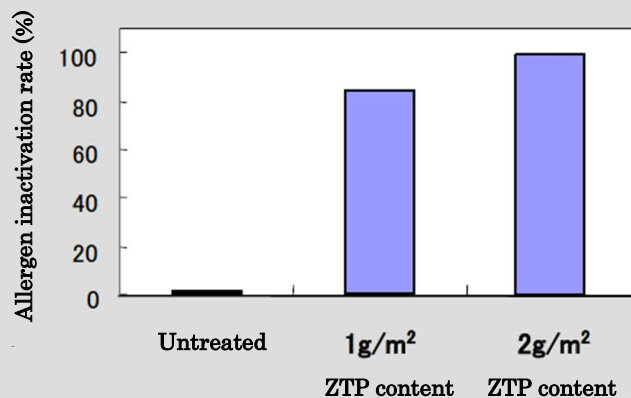


Figure 3: Activity against cedar pollen allergen (Cryj1)

We have also confirmed anti-allergen activity against other allergens such as cats (**Table 3**) and Japanese cypress.

Table 3: Activity of ZTP-170 against cat allergen

Allergen	ZTP-170	Amount of allergen added	Inactivation rate (%)
Feld1	3 mg	50 ng/mL	96

As shown above, we believe that inactivating allergens with AlleRemove ZTP-170, which has a high allergen inactivation rate, will provide a more comfortable living space.

3.2 Coloring property and discoloration

ZTP-170 is a pale-yellow agent that is close to white in appearance with minimal coloration, designed for use in visible textile products and similar applications (**Figure 4**). It is also a fine powder with a particle size of only a few μ m (**Figure 5**), shows little discoloration over time, and offers excellent processability.



Figure 4: AlleRemove ZTP-170

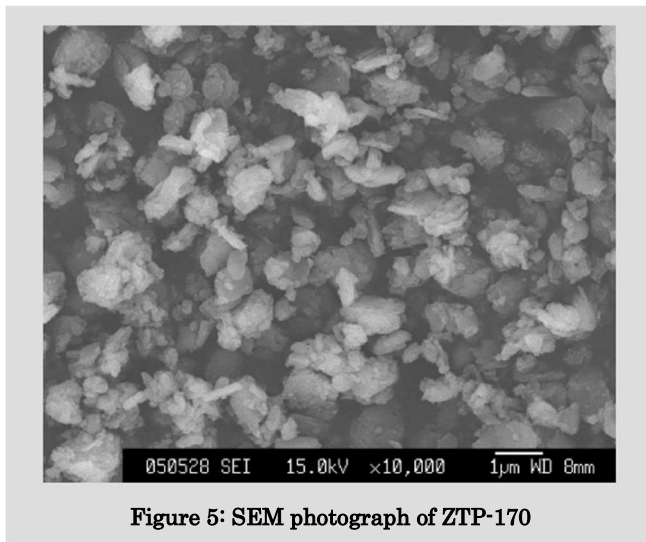


Figure 5: SEM photograph of ZTP-170

Figure 6 shows pieces of nonwoven fabric treated with ZTP-170 (left) or a polyphenol-based anti-allergen agent (right), each applied at 3 g/m² using an acrylic binder, and then heated at 120°C for 18 hours. The cloth treated with ZTP-170 showed almost no discoloration and an allergen inactivation rate exceeding 99% even after heat treatment (evaluated against Cryj1 under the same conditions as in 3.1). This demonstrates that ZTP-170 resists the heat encountered both during processing and during product use.



Figure 6: Nonwoven fabric treated with anti-allergen agent after heating

3.3 Water resistance

Because ZTP-170 is based on an inorganic material, it shows high resistance to leaching during washing once incorporated into textile products, and maintains its anti-allergen effect over time. Washing textiles treated only with anti-allergen agents, which are normally soluble in water, would cause the agents to run off and lose their effectiveness. However, ZTP-170 has an organic anti-allergen agent carried by an inorganic material and is water-resistant, resulting in a sustained effect. Figure 7 shows the allergen inactivation rate before and after simple washing using a washing machine for cotton/acrylic = 1/1 fabric coated with ZTP-170 at a loading of 2 g/m² using an acrylic binder. The evaluation was performed against Der f II under the same conditions as in Section 3.1. As shown here, ZTP-170 exhibits a high allergen inactivation rate and high water resistance even after washing.

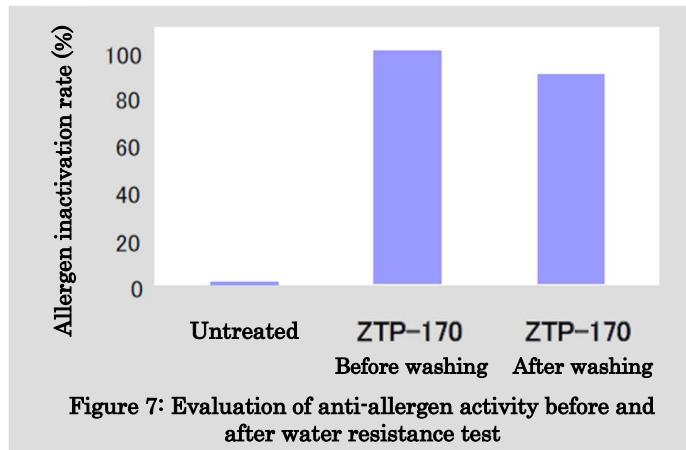


Figure 7: Evaluation of anti-allergen activity before and after water resistance test

3.4 Safety

While the organic and inorganic substances that make up ZTP-170 have been confirmed to be safe, the safety of ZTP-170 as a complex has also been confirmed with regard to acute oral toxicity in rats and primary skin irritation in rabbits (Table 4).

Table 4: Safety test data for ZTP-170

Acute oral toxicity LD50 in rats	> 5000 mg/kg
Primary skin irritation (P.I.I.) rabbit	0

4. Application examples

ZTP-170 can be used in a variety of applications, including filters for air purifiers, indoor products such as carpets and mats, car interior products such as car seats and car mats, bedding products such as sheets, pillows and comforter cotton, textile products such as masks, hats, and clothing, and housing construction material products such as wall and floor materials. Although the allergen inactivation performance of fibers treated with ZTP-170 varies depending on the amount of binder used in the chemical treatment, the water repellency of the fibers, and the shape of the fibers, we have confirmed that it is highly effective when it is applied to fabrics such as nonwovens, polyester, polypropylene, and polyethylene terephthalate. For example, Table 5 shows the anti-allergen activity in textile products prepared for car seats and air purifiers (evaluated under the same conditions as in 3.1). The most effective method is applying the agent to the product surface using an acrylic or urethane binder. Multi-functional products can also be created by combining ZTP-170 with antimicrobial agents or deodorants in the same treatment. Table 6 and Figure 8 show the anti-allergen activity and deodorization performance of the mixture of AlleRemove and our deodorant product “KESMON” applied to nonwoven fabrics using an acrylic binder (anti-allergen activity evaluation: Same conditions as in 3.1; deodorant performance evaluation: Initial ammonia concentration of 100 ppm, initial acetic acid concentration of 50 ppm). These results show that combining AlleRemove and KESMON delivers both anti-allergen activity and deodorization performance.

Table 5: Anti-allergen activity of ZTP-170 in different applications

Application	Car seat	Air purifier filter
Material	Polyester	Polypropylene /polyester, etc.
Applied amount of ZTP-170	2 g/m ²	3.5 g/m ²
Cryj1 inactivation rate (%)	97	90

Table 6: Anti-allergen activity of a combined formulation of AlleRemove/KESMON

Evaluated non-woven fabric	Allergen inactivation rate (%)	
	Cedar pollen allergen (Cryj1)	Mite allergen (Derf II)
Treated cloth	>99	>99
Untreated cloth	0	4

Reference

- 1) I. Nishioka, YAKUGAKU ZASSHI, **103** (2), 125 (1983).
- 2) Patent Application Publication Number S61-44821
- 3) Patent Application Publication Number H6-279273
- 4) T. Yoshida and M. Arii, "Development of Polyphenol-rich Functional Foods," CMC Publishing (2007).

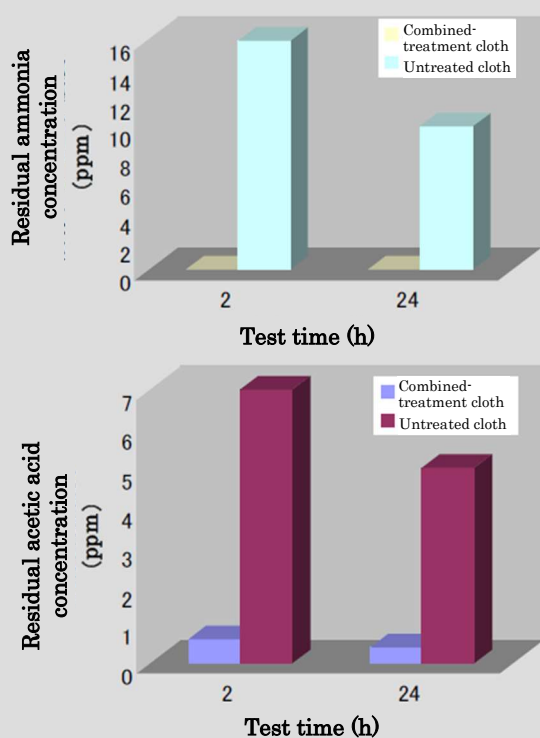


Figure 8: Deodorization performance of a combined formulation of AlleRemove/KESMON

5. Conclusion

As described above, we have developed AlleRemove ZTP-170, a new anti-allergen agent that delivers strong allergen inactivation along with low-coloration appearance, water resistance, processability, and safety. Currently, we have received many inquiries from various industries mentioned in the application examples above, and the product has been well-received. We are continuing development efforts so that more end users can adopt our products, and so that we can help provide comfortable living spaces for as many people as possible.