



(11)

EP 4 825 752 A1

(12)

EUROPEAN PATENT APPLICATION
 published in accordance with Art. 153(4) EPC

- (43)

Date of publication:
21.10.2026 Bulletin 2026/43

(51)

International Patent Classification (IPC):
B65D 85/48^(2006.01) B65D 57/00^(2006.01)
- (21)

Application number: 25811899.1

(52)

Cooperative Patent Classification (CPC):
B65D 57/00; B65D 85/48
- (22)

Date of filing: 18.07.2025

(86)

International application number:
PCT/JP2025/025689
- (87)

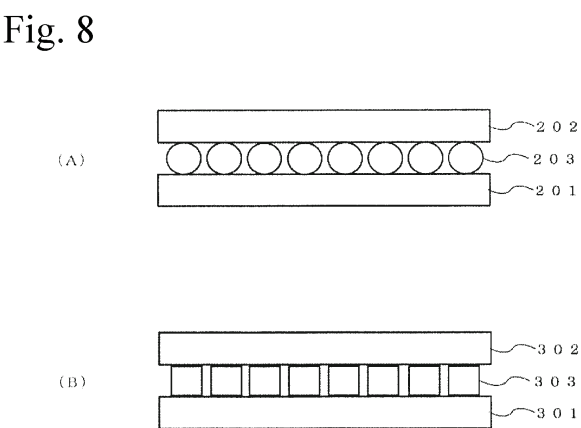
International publication number:
WO 2026/028837 (05.02.2026 Gazette 2026/06)

(84) Designated Contracting States: AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR Designated Extension States: BA Designated Validation States: GE KH LA MA MD TN (30) Priority: 31.07.2024 JP 2024124829 (71) Applicant: Nagara Paper Mfg. Co., Ltd. Mizuho City, Gifu 501-0211 (JP) (72) Inventors: • KOBAYASHI, Hideo Mizuho City, Gifu 5010211 (JP)	• ONDA, Hiroki Mizuho City, Gifu 5010211 (JP) • MATSUNAGA, Kaoru Mizuho City, Gifu 5010211 (JP) • IEDA, Seigo Mizuho City, Gifu 5010211 (JP) (74) Representative: Eisenführ Speiser Patentanwälte Rechtsanwälte PartGmbB Gollierstraße 4 80339 München (DE)
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CUSHIONING MATERIAL FOR GLASS PLATES AND GLASS LAMINATE

(57) A buffering material to be held between layered glass plates is obtained that minimizes adverse effects on the natural environment and has the properties necessary for holding layered glass plates together. The buffering material for glass plates to be placed between glass plates is a powder containing 50% by weight or more of a water-soluble inorganic salt component. Preferred water-soluble inorganic salt particles are sodium chloride particles 303 having a cubic shape. The sodium chloride particles 303 have parallel flat surfaces that come into surface contact with the surfaces of the glass plates 301 and 302, achieving high adhesion.



Description

Technical Field

5 **[0001]** The present invention relates to buffering material which is disposed between layered glass plates.

Background Art

10 **[0002]** When glass plates are carried, stored, and handled as a freight, buffering material is inserted between adjacent glasses layered multiply so as to prevent damage from generating by contact of glass plates each other. A technique is known in which powder consisting of synthetic resin particles (beads) having particle diameter of several tens to several hundreds μm is used as the buffering material (for example, see Patent document 1).

[0003] Patent document 1: U.S. Patent No. 10611546

15 Summary of Invention

[0004] There are concerns about environmental impact of the powder used as the buffering material. For example, when the powder is sprinkled onto surface of a glass plate, the powder falls off the surface of the glass plate. Although the powder that falls off the glass plate is collected, there is no guarantee that it is completely collected, and there is a risk that it may be released into the environment (for example, mixed with cleaning water and flowing into the sewer). Furthermore, the powder is removed from the surface of the glass plate during secondary processing (cutting or processing for productization), and there is a similar risk in this case. Furthermore, although the amount is small, there is a possibility that the powder may scatter during transportation or transfer in production process in which the glass plates laminated via the powder are used.

25 **[0005]** From the viewpoint of protecting the natural environment, it is undesirable for synthetic resin powder to be released into the environment. For example, there are concerns that the accumulation of synthetic resin powder may have a negative impact on fish, shellfish, birds, and other animals.

[0006] On the other hand, the glass plates are required to have a high level of surface quality (flatness, absence of scratches and dirt), and to reliably protect the layered glass plates during transport, the powder held between the glass plates must also have high functionality (strength and retainability).

30 **[0007]** In view of such circumstances, an object of the present invention is to provide a highly functional material that can be used as buffering material to be held between layered glass plates. The present invention also aims to provide a material that minimizes adverse effects on the natural environment and has the functionality necessary to hold layered glass plates.

35 Summary of Invention

[0008] One aspect of the present invention is a buffering material for glass plate, which is held between glass plates, including particles having cubic shape having coating layer, in which the coating layer contains water-soluble cellulose, the particle is sodium chloride particle, and the buffering material contains 50 weight% or more of the sodium chloride particle component. Another aspect of the present invention is a buffering material for glass plate, which is held between glass plates, comprising powder containing 50 weight% or more of cubic crystal structure component, in which particles composing the powder are particles of sodium chloride having cubic shape. In the present invention, an aspect can be mentioned in which equivalent circle diameter of the particle is 10 μm to 250 μm . In the present invention, an aspect can be mentioned in which the particle has coating layer of cellulose.

45 **[0009]** Another aspect of the present invention is a glass layered body in which at least two glass plates are layered via a buffering material for glass plate, in which the buffering material for glass plate is powder containing 50 weight% or more of sodium chloride component having cubic crystal structure. Another aspect of the present invention is a glass layered body in which at least two glass plates are layered via a buffering material for glass plate, in which the buffering material for glass plate is powder containing 50 weight% or more of sodium chloride particle component having two flat surfaces being mutually parallel, and one of the two parallel flat surfaces contacts surface of one of the two glass plates, and the other of the two parallel flat surfaces contacts surface of the other of the two glass plates.

Effect of Invention

55 **[0010]** According to the present invention, as a buffering material to be held between layered glass plates, it is possible to obtain a material that has a reduced adverse effect on the natural environment and has the function required to hold the layered glass plates.

Brief Description of Drawings

[0011]

Fig. 1 is a conceptual diagram of the embodiment.

Fig. 2 is a photograph showing microgram of sodium chloride particles.

Fig. 3 is an illustration showing a cross-sectional structure of sodium chloride particles having coating layer.

Fig. 4 is a photograph showing microgram of sodium chloride particles not having coating layer.

Fig. 5 is a photograph showing microgram of sodium chloride particles having coating layer.

Fig. 6 is an illustration showing a method to measure adhesion to the glass plate.

Fig. 7 is a graph showing results of measuring adhesion of sodium chloride particles and acrylic resin particles onto the glass plate.

Fig. 8 is an illustration showing condition in which sodium chloride particles having cubic shape adhere on the glass plate.

Fig. 9 is a graph showing relationship between pressure on sodium chloride particles and amount of deformation.

Fig. 10 a graph showing relationship between pressure on acrylic particles and amount of deformation.

Fig. 11 a graph showing relationship between pressure on mirabilite particles and amount of deformation.

Embodiments of Invention

1. First Embodiment

(Summary)

[0012] The powder of the buffering material for glass plate explained here has following features:

- (1) Little adverse impact on the environment.
- (2) High adhesion to glass plates due to the particle shape.
- (3) High dispersibility when applied to the surface of glass plates.
- (4) Sufficient strength to hold layered glass plates together.
- (5) Glass is resistant to staining.
- (6) Easy to clean.

[0013] Fig. 1 shows a condition in which four glass plates 101, 102, 103, and 104 are layered. The number of glass plates that can be layered is not limited, and two or more plates are possible. Four plates are shown here as an example. The applications of the glass plates are not limited, but examples include architecture, vehicles, displays, and solar cells.

[0014] A particle layer 111 is provided between the glass plates 101 and 102, a particle layer 112 is provided between the glass plates 102 and 103, and a particle layer 113 is provided between the glass plates 103 and 104.

[0015] The particle layer 111 functions as a buffering layer which prevent the glass plates 101 and 102 from contacting directly. The particle layers 112 to 113 also have this function. Furthermore, the particle layers 111 to 113 have a function of holding adjacent glass plates above and below so that they do not move relative to each other due to vibration or impact, and a function of absorbing vibration and impact. Thickness of the particle layers 111 to 113 is about 10 μm to 400 μm , and desirably about 50 μm to 150 μm .

(Particles composing particle layer)

[0016] The particle layers 111 to 113 have powder of sodium chloride (NaCl) as a main component. In each layer of the particle layers 111 to 113, ratio of sodium chloride (NaCl) component is 50 weight% to 99.9 weight%, desirably 80 weight% to 99.9 weight%, and more desirably 95 weight% to 99.9 weight%. The remainder is coating layer covering the sodium chloride particles, additives added as needed, or inevitable impurities.

[0017] The particles composing sodium chloride powder (sodium chloride particles) have cubic shape (regular hexahedron). Cubic sodium chloride particles are obtained by isotropic crystal growth. The cubic shape also includes shapes with rounded corners. In this case, it is preferable that 80% or more of the surface is flat. The term "particle" refers to an individual grain.

[0018] The particle diameter of sodium chloride particles is understood by circle equivalent diameter, and it is 10 μm to 400 μm in average value, and desirably 10 μm to 250 μm . Fig. 2 is a micrograph of sodium chloride particles used in this Embodiment.

[0019] As shown in Fig. 2, sodium chloride particles used in this Embodiment have a cubic (dice) shape. The particle size distribution of sodium chloride powder is preferably narrow (sharp). By narrowing the distribution width, the amount of unnecessary (small) particles that do not support the glass can be reduced, making it more economical.

[0020] Sodium chloride has a sodium chloride type crystal structure, which is one of the cubic crystal structures. This crystal structure is the basic structure of a cubic (regular hexahedron) particle shape. The cubic sodium chloride particles used in this Embodiment are obtained by isotropically growing the basic cubic crystal structure.

[0021] The cubic sodium chloride particles have parallel flat faces. These faces come into surface contact with the glass surface, which allows the powder composed of the sodium chloride particles to have adhesion property and tight adhesion property to the glass plate, as described below. This effect is true for all particles obtained by isotropically growing a cubic crystal structure.

(Coating layer)

[0022] The sodium chloride particles used in this Embodiment are covered on their surfaces with a biodegradable coating layer (covering layer). Known biodegradable materials can be used for the coating. An example of the biodegradable material is water-soluble cellulose. Here, an aqueous solution of water-soluble cellulose is spray-coated onto the surfaces of the sodium chloride particles to form a water-soluble cellulose coating layer on the surfaces of the sodium chloride particles. Thickness of the coating layer when dried is about 1 μm to 20 μm , preferably 2 μm to 10 μm . Proportion of the water-soluble cellulose component in the coating layer is 50 wt% or more.

[0023] Spray coating is a method in which particles are suspended in an air current to form a fluidized bed, and an aqueous solution containing a coating material is sprayed to the fluidized bed to adhere the coating material to the particle surface and then dried, forming a coating layer. In the spray coating, the thickness of the coating layer can be controlled by adjusting the temperature and air volume of the air current used to form the fluidized bed, as well as the concentration and spraying conditions of the aqueous solution containing the coating material.

[0024] Fig. 3 is a cross-sectional illustration of the sodium chloride particles 150 on which the coating layer 151 is coated. By arranging the coating layer 151, dispersibility of the powder composed of the sodium chloride particles 150 can be increased.

[0025] Fig. 4 is the micrograph of condition in which the sodium chloride particles not having coating layer are sprinkled on the glass plate. Table 1 shows a particle size distribution of the sodium chloride particles not having coating layer in Fig. 4.

Table 1

Sodium chloride particles not having coating layer							
Accumulated diameter	1	2	3	4	5	Average	σ
x10	202.4	202.7	202.9	206.2	211.00	205.0	3.7
x50	262.4	267.5	269.3	277.7	289.7	273.3	10.7
x90	340.6	348	355.2	366.1	375.4	357.1	13.9
							(unit: μm)

[0026] Fig. 5 is the micrograph showing condition in which the sodium chloride particles having coating layer are sprinkled on the glass plate. Table 2 shows a particle size distribution of the sodium chloride particles having coating layer in Fig. 5.

Table 2

Sodium chloride particles having coating layer							
Accumulated diameter	1	2	3	4	5	Average	σ
x10	205.9	213	188.2	191.1	201.9	200.0	10.3
x50	264.5	275.2	244	270.6	240.3	258.9	15.8
x90	339.5	345.3	310.5	364.4	289.5	329.8	29.7
							(unit: μm)

[0027] It should be noted that the coating layer in the case of Fig. 5 is a layer of water-soluble cellulose, and the

thickness thereof is about 4 μm . Here, the water-soluble cellulose used was "Metolose" (registered trademark) manufactured by Shin-Etsu Chemical Co., Ltd. The spray coating was carried out using a fluidized bed apparatus MP01 manufactured by Powrex Corporation.

[0028] As is obvious from comparison of Figs. 4 and 5, dispersibility of the sodium chloride particles is improved by arranging the coating layer.

[0029] Table 3 shows data showing the dispersibility of the sodium chloride particles shown in Fig. 4, which do not have a water-soluble cellulose coating layer, on a glass plate. Here, the sodium chloride powder was sprinkled on a glass slide, images were taken with a microscope, and the number of particles was counted before calculating the dispersion ratio. In Table 3, dispersed particles are separated (isolated) particles, and agglomerated particles are particles in which two or more particles have aggregated and can be considered as a single particle.

[0030] The dispersion ratio is the proportion of particles that can be considered as a single isolated particle to all particles to be measured on the glass plate. A dispersion ratio of 100% occurs when all particles to be measured are observed as a single isolated particle. The higher the dispersion ratio, the more uniformly the particles are distributed on the glass plate. The smaller the dispersion ratio, the greater the proportion of particles in a state where two or more particles are aggregated, and the greater the tendency for the particle distribution to become non-uniform.

Table 3

Sodium chloride particles having no coating layer				
Sample No.	Total number of particles Number of dispersed particles + Number of particles composing aggregated particles	Aggregated particles		Dispersion ratio (%) Number of dispersed particles / Number of total particles
		Total number	Number of constituent particles	
1	235	58	177	24.7
2	197	52	168	14.7
3	188	50	150	20.2
4	110	34	90	18.2
5	223	67	203	9.0
			Average Dispersion ratio	17.35

[0031] Table 4 shows data showing the dispersibility of the sodium chloride particles shown in Fig. 5, which have a water-soluble cellulose coating layer, on a glass plate. Experimental conditions are the same as those in Table 3.

Table 4

Sodium chloride particles having coating layer				
Sample No.	Total number of particles Number of dispersed particles + Number of particles composing aggregated particles	Aggregated particles		Dispersion ratio (%) Number of dispersed particles / Number of total particles
		Total number	Number of constituent particles	
1	83	3	6	92.8
2	215	8	17	92.1
3	80	6	13	83.8
4	175	6	13	92.6
5	121	13	22	81.8
			Average Dispersion ratio	88.60

[0032] From Tables 3 and 4, it is obvious that sodium chloride particles on which coating layer is formed have high

dispersibility. Table 5 is a data of dispersibility of acrylic powder. Table 6 is a particle size distribution of acrylic particles of Table 5. As shown in Table 5, dispersibility of the acrylic particles is not good compared to that of the sodium chloride particles having coating layer. In addition, the acrylic particles have a high electrostatic property, and in actual use, the dispersibility tends to be lower than the data in Table 5.

Table 5

Acrylic particles				
Sample No.	Total number of particles Number of dispersed particles + Number of particles composing aggregated particles	Aggregated particles		Dispersion ratio (%) Number of dispersed particles / Number of total particles
		Total number	Number of constituent particles	
1	665	186	323	51.4
2	746	155	416	44.2
3	591	115	305	48.4
4	527	92	254	51.8
5	662	13	398	39.9
			Average Dispersion ratio	47.15

Table 6

Acrylic particles							
Accumulated diameter	1	2	3	4	5	Average	σ
x10	129.1	130.1	130.6	131	130.9	130.3	0.8
x50	168.6	168.8	167.3	170.7	166.5	168.4	1.6
x90	227.1	223.7	218.9	227.2	214.6	222.3	5.5
							(unit: μm)

[0033] High dispersibility means high flowability as powder. In the process of sprinkling the powder onto the glass plate, it is desirable that the powder can be sprinkled with good dispersibility without agglomeration. If the particle dispersibility is poor, holding layer that holds the layered glass plates tends to be uneven (tend to be patchy). If the holding layer becomes uneven, partial gaps will be generated, which increases the possibility of glass discoloration, which is undesirable. From this viewpoint, providing the above-mentioned coating layer is highly effective in increasing the dispersibility of the particles.

[0034] The coating layer also functions to prevent direct contact of sodium chloride component with the glass plate surface. Direct contact of sodium and chlorine components with the glass plate surface can cause scale-like damage which is scale-like marks. The provision of coating layer 151 can prevent this problem.

[0035] The glass discoloration is a known problem caused by the elution of alkaline components from the interior of the glass plate onto the glass plate surface. One method for preventing this phenomenon is to supply alkaline components to the glass plate surface from the outside, thereby suppressing the elution of alkaline components from the interior of the glass plate. The coating layer 151 also functions as a buffering layer that ensures the appropriate supply of alkaline components from the sodium chloride particles 150 to the glass plate surface. Therefore, the coating layer 151 functions to prevent the occurrence of scale-like damage caused by the material of the sodium chloride particles 150 themselves, and to suppress glass discoloration by appropriately supplying alkaline components to the glass plate surface.

[0036] In addition to cellulose, materials that can be used to compose the coating layer 151 include organic acids (adipic acid, succinic acid, citric acid), water-soluble inorganic salts (such as mirabilite), sodium acetate (organic acid sodium salts), PLA (biodegradable resin), and combinations of these materials. One method for forming a coating layer made of these materials is the spray coating method.

[0037] The spray coating method can be used regardless of whether the material to be coated is water-soluble. For water-soluble materials, an aqueous solution of the material is used as the spray solution. For water-insoluble or

poorly water-soluble materials, a liquid in which a fine powder of the material is dispersed is used as the spray solution. For water-insoluble or poorly water-soluble materials, the particle diameter of the fine powder particles should be 10% or less, preferably 5% or less, of the particle size of the base particles. In this case, a coating layer is formed in which many particles of the powder cling to the surface of the base particles.

[0038] For example, suppose a coating layer of adipic acid is formed on cellulose particles with an average particle size of 150 μm . In this case, a coating layer of the desired thickness is formed using a spray coating method, for example, using a liquid containing adipic acid particles with an average particle size of 1 μm as the spray liquid. In this case, the surface of the cellulose particles is covered with a large number of adipic acid microparticles distributed in layers. The coating layer is formed from these large number of adipic acid microparticles distributed in layers.

[0039] An embodiment in which the coating layer contains a biodegradable material and water-soluble inorganic salts and/or organic acids is also possible. For example, a coating layer can be formed using a spray coating method using an aqueous solution containing water-soluble cellulose and water-soluble inorganic salts as the spray liquid. Alternatively, a coating layer can be formed using a spray coating method using an aqueous solution containing water-soluble cellulose and organic acid particles as the spray liquid.

(Adhesion to glass plates)

[0040] Fig. 6 is an illustration of a method for measuring adhesion to glass plates. In the method shown in Fig. 6, powder is first sprinkled onto a horizontally placed glass plate, which is then held upright and impacted with a hammer. The total area of the powder adhering to the glass plate surface before and after the impact is determined using image analysis. The particle retention rate is calculated by dividing the total area of the particles adhering after impact by the total area of the particles adhering before impact. The particle retention rate is the percentage of powder particles that did not fall off the glass plate surface due to the impact.

[0041] Fig. 7 shows the results of measuring the particle retention rate of sodium chloride particles and acrylic particles (PMMA) on glass plates. The horizontal axis represents the hammer angle in Fig. 6. Table 7 presents the measurement results used to calculate Fig. 7. The hammer angle corresponds to the impact acceleration applied to the glass plate. The greater the hammer angle, the greater the impact acceleration applied to the glass plate. According to the findings of the present inventors, as a guideline, the impact acceleration applied to the glass plate when the hammer angle is 30° is 100 G, the impact acceleration applied to the glass plate when the hammer angle is 45° is 390 G, and the impact acceleration applied to the glass plate when the hammer angle is 60° is 680 G.

Table 7

		Hammer angle (°)			σ		
		30	45	60	30	45	96
Particle retention rate (%)	Sodium chloride particles	98.4	95.6	78.1	2.6	6.2	1.0
	Acrylic particles	98.0	78.0	47.7	0.3	12.0	0.4

[0042] The sodium chloride particles used had the particle shape shown in Fig. 2 and the particle size distribution shown in Table 1. The PMMA sample used had the particle size distribution shown in Table 6. It should be noted that the sample shown in Fig. 7 did not have a biodegradable coating layer.

[0043] PMMA powder is currently used in the industry as a buffering material for glass plates. Therefore, based on the results in Fig. 7, it can be said that the sodium chloride particles with the particle shape shown in Fig. 2 have adhesive properties that are equal to or greater than the appropriate adhesive properties of PMMA.

(Considerations regarding adhesion)

[0044] Fig. 8 is an illustration showing the adhesion of particles to glass plates. Fig. 8(A) shows spherical particles 203 (e.g., acrylic particles) held between glass plates 201 and 202. Fig. 8(B) shows cubic particles 303 (e.g., sodium chloride particles) held between glass plates 301 and 302.

[0045] In Fig. 8(A), the particle's contact with the glass plate is close to point contact. In contrast, in Fig. 8(B), the particle's contact with the glass plate is surface contact. For the same material, the larger the contact area, the greater the adhesion force of the particle to the glass plate surface. When considering the contribution to adhesion, the difference between point contact and surface contact is large, and this is thought to be the reason for the good adhesion (high adhesion) of the sodium chloride powder to glass plates.

[0046] In particular, cubic particles have three sets of parallel flat surfaces that intersect at right angles, and ideally have the same area, so there is a high probability that two flat surfaces of each particle will come into contact with the

opposing glass surface. This results in particularly strong tight adhesion to the glass plate surface, and therefore strong adhesion property to the glass plate surface.

(Particle Strength)

[0047] Deformation strength was measured as particle strength. Elastic-plastic or malleable materials often undergo continuous deformation without breaking. Therefore, focusing on the degree of deformation, the applied force when the particle was compressed to 50% of its diameter was measured as deformation strength.

[0048] Measurements were performed on 10 samples using a microparticle crushing force measuring device (NS-A300, manufactured by Nano Seeds). The particles were compressed with a crushing needle, and a waveform chart of compressive force was recorded. The amount of deformation was measured from displacement of the crushing needle.

[0049] The deformation strength is defined as $\sigma_{10\%} = F_{10\%}/A$ (JIS Z 8844). Here, $\sigma_{10\%}$ is the deformation strength (Pa) for a compressive displacement of 10% of the particle diameter. $F_{10\%}$ is the test force (N) for a compressive displacement of 10% of the particle diameter. A is the area (m²) of the equivalent circle determined from the particle diameter measured before compression. It should be noted that particle diameter was measured using image analysis. Here, a deformation strength of $\sigma_{50\%}$, which is even stronger than the JIS standard, was measured. Table 8 shows the measurement data for particle strength. Measurements were performed on particles without a coating layer.

Table 8

Sample name	Average particle diameter (μm)	Deformation strength (MPa)
Acrylic particle	119	137
Cellulose particle	119	173
Mirabilite particle	141	67
Sodium chloride particle	175	212

[0050] Acrylic particles are used as a buffering material for glass plates conventionally. Figs. 9 to 11 are graphs showing relationship between the pressing force (vertical axis) applied by the crushing needle to each particle measured using the microparticle crushing force measuring device and the amount of particle deformation. Here, Fig. 9 shows data for sodium chloride particles, Fig. 10 for acrylic particles, and Fig. 11 for mirabilite particles. The sodium chloride particles in Fig. 9 and the acrylic particles in Fig. 10 show deformation roughly proportional to the force applied. The waveform distortion in the mirabilite particle data in Fig. 11 indicates that the particles have been crushed by pressure. These findings suggest that sodium chloride particles possess sufficient strength to meet the requirements for a buffering material for glass plates.

[0051] Furthermore, the sodium chloride particles in Fig. 9 exhibit deformation closer to elastic deformation than the acrylic particles in Fig. 10. This means that when used as a buffering material for glass plates, sodium chloride particles can more effectively absorb impacts and vibrations applied to layered glass plates than acrylic particles.

(Example 1)

[0052] Sodium chloride powder with the particle shape shown in Fig. 2 and the particle size distribution shown in Table 2 was used for the particle layers 111-113 in Fig. 1.

[0053] The particles (sodium chloride particles) that make up this sodium chloride powder were coated with a water-soluble cellulose solution by spray coating the surface of the sodium chloride particles. The coating layer had a thickness (when dry) of 4 μm. Shin-Etsu Chemical's "Metolose" (registered trademark) was used as the water-soluble cellulose. Spray coating was performed using a fluidized bed device MP01 manufactured by Powrex Corporation.

(Example 2)

[0054] Table 9 shows the measured values for deformation strength, etc., of acrylic particles and sodium chloride particles without a coating layer. It should be noted that the sodium chloride particles have a cubic appearance, as shown in Fig. 2. The average adhesion strength is the adhesion strength to a glass plate.

[0055] Adhesion strength was measured using a centrifugal adhesion force measurement device (NS-C100, manufactured by Nano Seeds Corporation). In this measurement, a sample was attached to the surface of a substrate (glass plate), and the substrate was centrifuged at six levels between 100 G and 800 G in a centrifuge. Images of the

particle separation were recorded, and the particle retention rate after rotation was measured relative to the initial number of particles attached before centrifugation.

[0056] The adhesion force of a particle to a substrate is equivalent to the centrifugal separation force acting on the particle, and was calculated using the formula $F = (\pi/6)\rho d^3 r \omega^2$. Where ρ is the true density of the particles, d is the particle diameter, r is the rotation radius of the centrifuge, and ω is the rotation angular velocity of the centrifuge. The particle retention rate after rotation was plotted on the horizontal axis and the particle separation force at each rotation part was plotted on the vertical axis, and the average adhesion force (separation force at which 50% of the particles separate) was calculated from the exponential approximation curve.

Table 9

Sample name	10% deformation strength (MPa)	50% deformation strength (MPa)	Average adhesion force (nN) (125-150 μm)	Average particle diameter (μm)
Acrylic particle	32.04	136.54	10670.47	133.6
Sodium chloride particle	49.70	211.63	41616.81	212.1

[0057] Table 9 shows that the sodium chloride particles have high strength and good adhesion to glass plates.

(Example 3)

[0058] The test shown in Fig. 6 was conducted on the sodium chloride particles with a water-soluble cellulose coating layer (Table 2) and the sodium chloride particles without a coating layer (Table 1). Tables 10 and 11 show the test results (particle retention rate).

Table 10

With coating layer			
	Hammer angle (°)		
	30	45	60
Particle retention rate (%)	68.6	22.4	5.4
σ	13.9	6.6	4.8

Table 11

Without coating layer			
	Hammer angle (°)		
	30	45	60
Particle retention rate (%)	98.4	95.6	78.1
σ	2.6	6.2	1.0

[0059] The adhesion of sodium chloride particles with a coating layer to glass plates is reduced compared to particles without a coating layer. However, impact tests at hammer angles of 45° and 60° are quite severe test conditions, and it is believed that sodium chloride particles with a coating layer also have adhesion properties against practical impacts.

(Example 4)

[0060] An aspect is also possible to incorporate organic acid particles into the coating layer of sodium chloride particles. In this case, the particle diameter of the organic acid is approximately the thickness of the coating layer or less. For example, the coating layer is composed of water-soluble cellulose and fine powder of adipic acid. The sodium chloride particles listed in Table 1 are used as base particles. The coating layer is formed by a spray coating method using a mixture of an aqueous solution of water-soluble cellulose and adipic acid with an average particle size of 2 μm as the spray liquid. The thickness of the coating layer is approximately 5 μm . The mixture ratio of water-

soluble cellulose to adipic acid is 90:10 to 99:1, e.g., 95:5, by weight when dried.

[0061] In the case of this example, adipic acid particles are incorporated into a coating layer of water-soluble cellulose. This coating layer structure is expected to provide high dispersibility due to existence of the coating layer itself, and also to provide functions to prevent glass discoloration and improve adhesion to the glass plate by the incorporated adipic acid particles.

(Example 5)

[0062] The coating layer is composed of a fine powder of an organic acid. In this example, the coating layer is composed of a fine powder of adipic acid. The base particles are sodium chloride particles listed in Table 1. The coating layer is formed using a spray coating method, using a spray liquid containing adipic acid with an average particle diameter of 1 μm . The thickness of the coating layer is approximately 5 μm . In the case of this example, the coating layer is formed from numerous adipic acid particles distributed in a shell-like pattern.

(Advantages)

[0063] Sodium chloride powder has the following advantages as a buffering material for glass plates:

- (1) Minimal environmental impact.
- (2) High adhesion to glass plates due to the particle shape.
- (3) High dispersibility when applied to the glass plate surface.
- (4) Sufficient strength to hold layered glass plates together.
- (5) Glass is less susceptible to soiling.
- (6) Easy to clean.

[0064] Sodium chloride is a natural substance found in nature and has little adverse environmental impact like synthetic resin particles.

[0065] A powder-based buffering material for glass plates requires high adhesion to the glass plates. From this viewpoint, as shown in Fig. 8, cubic sodium chloride particles 303 have parallel flat surfaces that come into surface contact with the surfaces of glass plates 301 and 302, achieving high adhesion.

[0066] Current acrylic powders have the problem of poor dispersibility on glass plates (see Table 5). Poor powder dispersibility on glass plates results in uneven distribution of the powder between layered glass plates, generating gaps where the particle layer is absent. When layered glass plates are stored for long periods, these gaps can cause glass discoloration. Sodium chloride powder with a coating layer has high dispersibility, thereby reducing the problems caused by the uneven particle layer.

[0067] Furthermore, the particles in the powder-based buffering material for glass plates must be strong. This is because if the particles break under the pressure of layering the glass plates, it may cause contact between the glass plates and damage the glass plate surfaces. Cubic-shaped sodium chloride particles are crystalline and possess the strength required for a buffering material for glass plates.

[0068] By applying a water-soluble cellulose coating to the surface of sodium chloride particles, the sodium chloride component does not come into direct contact with the glass, preventing contamination of the glass by the sodium chloride component. Furthermore, the sodium chloride can be easily removed from the glass surface by rinsing with water, making cleaning easy.

2. Other Embodiments

[0069] Particles having a sodium chloride-type crystal structure include magnesium oxide particles. Furthermore, particles having a cubic crystal structure include alum particles (potassium alum, etc.). These particles are also obtained by isotropically growing a basic crystal structure. These particles also have flat surfaces and exhibit good adhesion to glass plates, similar to the sodium chloride particles described above. The particle size, coating layer formation, and other details are the same as those described in the specification. Magnesium oxide and alum are naturally occurring substances and do not have the adverse environmental impact unlike synthetic resins. It is also possible to use a mixture of two or more of sodium chloride particles, magnesium oxide particles, and alum particles.

3. Other matters

[0070] It is also possible to dry or charge powders composed of particles having the cubic crystal structure exemplified herein. Drying or charging the powder can improve adhesion to glass plates.

[0071] As shown in Tables 10 and 11, sodium chloride particles coated with a water-soluble cellulose layer exhibit reduced adhesion to glass plates compared to particles without the coating. One possible method to prevent this decrease is to hydrophobize the water-soluble cellulose coating layer. Hydrophobization makes it more difficult for particles to adsorb moisture, increasing their chargeability. This improves adhesion to glass plates. Examples of hydrophobization treatments include fluorine plasma treatment and plasma treatment in a reducing atmosphere using hydrocarbons (e.g., methanol).

[0072] Various additives can also be used. These additives can be introduced by (1) mixing them as particles, (2) mixing an aqueous solution containing the additive as described above with a coating liquid for forming a coating layer made of a biodegradable resin and then forming the resulting coating on the surface of the base particles, or (3) forming an additional coating layer on the surface of the base particles using an aqueous solution or sol containing the additive, separate from the coating layer made of a biodegradable resin.

[0073] The technique disclosed in this specification reduces the impact on the natural environment and produces a glass layered body that meets the requirements for holding glass plates layered together.

[0074] The invention disclosed in this specification is described below. The invention disclosed in this specification is a buffering material for glass plates that is to be interposed between glass plates, and includes cubic-shaped particles with a coating layer. In one embodiment, the coating layer includes water-soluble cellulose, and the particles are sodium chloride particles.

[0075] The invention disclosed in this specification is a buffering material for glass plates that is to be interposed between glass plates, and is a powder containing 50% or more by weight of a component with a cubic crystal structure. In one embodiment, the particles that make up the powder have a sodium chloride-type crystal structure. In one embodiment, the particles that make up the powder have a cubic shape. In one embodiment, the particles that make up the powder have two parallel planes. In one embodiment, the particles that make up the powder have flat surfaces. In one embodiment, the particles that make up the powder are at least one of sodium chloride particles, magnesium oxide particles, and alum particles. In one embodiment, the particles make up the powder have an equivalent circle diameter of 10 μm to 250 μm . In one embodiment, the surfaces of the particles that make up the powder are covered with a biodegradable coating layer. In one embodiment, the coating layer contains a water-soluble inorganic salt and/or an organic acid. In one embodiment, the particles that make up the powder are sodium chloride particles, and the surfaces of the particles that make up the powder are covered with a water-soluble cellulose coating layer. In one embodiment, the dispersion rate of the powder, when dispersed on a glass plate, is defined as (number of dispersed particles/total number of particles), with isolated particles being considered dispersed particles, and the dispersion rate of the powder is 80% or more.

[0076] The invention disclosed in this specification is a buffering material for glass plates to be interposed between glass plates, the buffering material being a powder containing 50% by weight or more of cubic-shaped particles.

[0077] The invention disclosed in this specification is a buffering material for glass plates to be interposed between glass plates, the buffering material being a powder containing 50% by weight or more of particles having a cubic crystal structure and formed into a cubic shape by isotropically growing the cubic crystal structure.

[0078] The invention disclosed in this specification is a glass layered body in which at least two glass plates are layered together with a buffering material for glass plates therebetween, the buffering material for glass plates being a powder containing 50% by weight or more of components with a cubic crystal structure.

[0079] The invention disclosed in this specification is a glass layered body in which at least two glass plates are layered together with a buffering material for glass plates therebetween, the buffering material for glass plates being a powder containing particles having two parallel planes, one of the two parallel planes contacting a surface of one of the two glass plates and the other of the two parallel planes contacting a surface of the other of the two glass plates.

[0080] The particles that make up the powder may be at least one of sodium chloride particles, magnesium oxide particles, and alum particles.

Explanation of Reference Numerals

[0081] 101: Glass plate, 102: glass plate, 103: glass plate, 104: glass plate, 111: particle layer, 112: particle layer, 113: particle layer, 150: sodium chloride particle, 151: coating layer, 201: glass plate, 202: glass plate, 203: spherical shape particle, 301: glass plate, 302: glass plate, 303: cubic shape particle (sodium chloride particle).

Claims

1. A buffering material for glass plate, which is held between glass plates, comprising particles having cubic shape having coating layer,

wherein the coating layer contains water-soluble cellulose,
the particle is sodium chloride particle, and
the buffering material contains 50 weight% or more of the sodium chloride particle component.

- 5 **2.** A buffering material for glass plate, which is held between glass plates, comprising powder containing 50 weight%
or more of cubic crystal structure component,
wherein particles composing the powder are particles of sodium chloride having cubic shape.
- 10 **3.** The buffering material for glass plate according to claim 1 or 2, wherein equivalent circle diameter of the particle is
10 μm to 250 μm .
- 4.** The buffering material for glass plate according to claim 2, wherein the particle has coating layer of cellulose.
- 15 **5.** A glass layered body in which at least two glass plates are layered via a buffering material for glass plate,
wherein the buffering material for glass plate is powder containing 50 weight% or more of sodium chloride
component having cubic crystal structure.
- 6.** A glass layered body in which at least two glass plates are layered via a buffering material for glass plate,
20 wherein the buffering material for glass plate is powder containing 50 weight% or more of sodium chloride
particle component having two flat surfaces being mutually parallel, and
one of the two parallel flat surfaces contacts surface of one of the two glass plates, and the other of the two
parallel flat surfaces contacts surface of the other of the two glass plates.

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Fig. 1

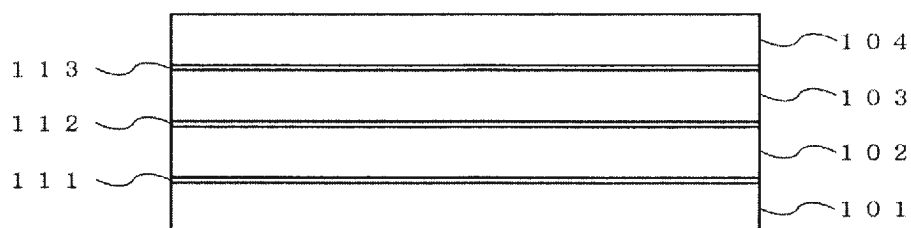


Fig. 2

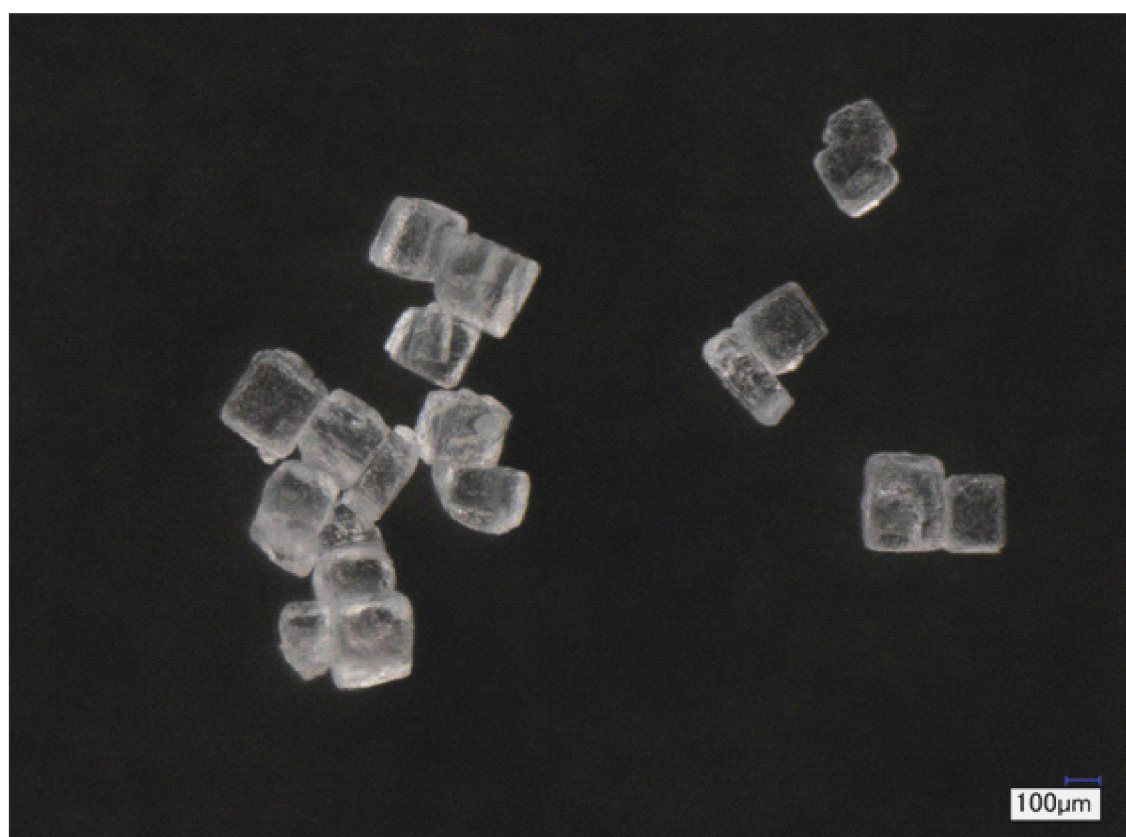


Fig. 3

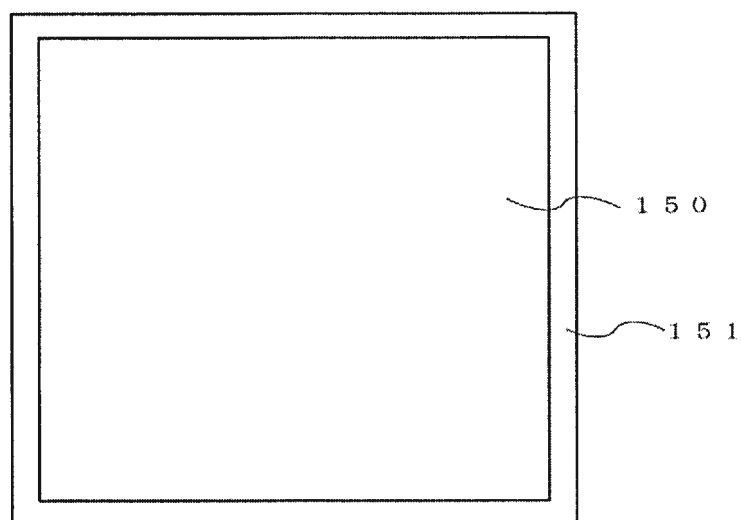


Fig. 4

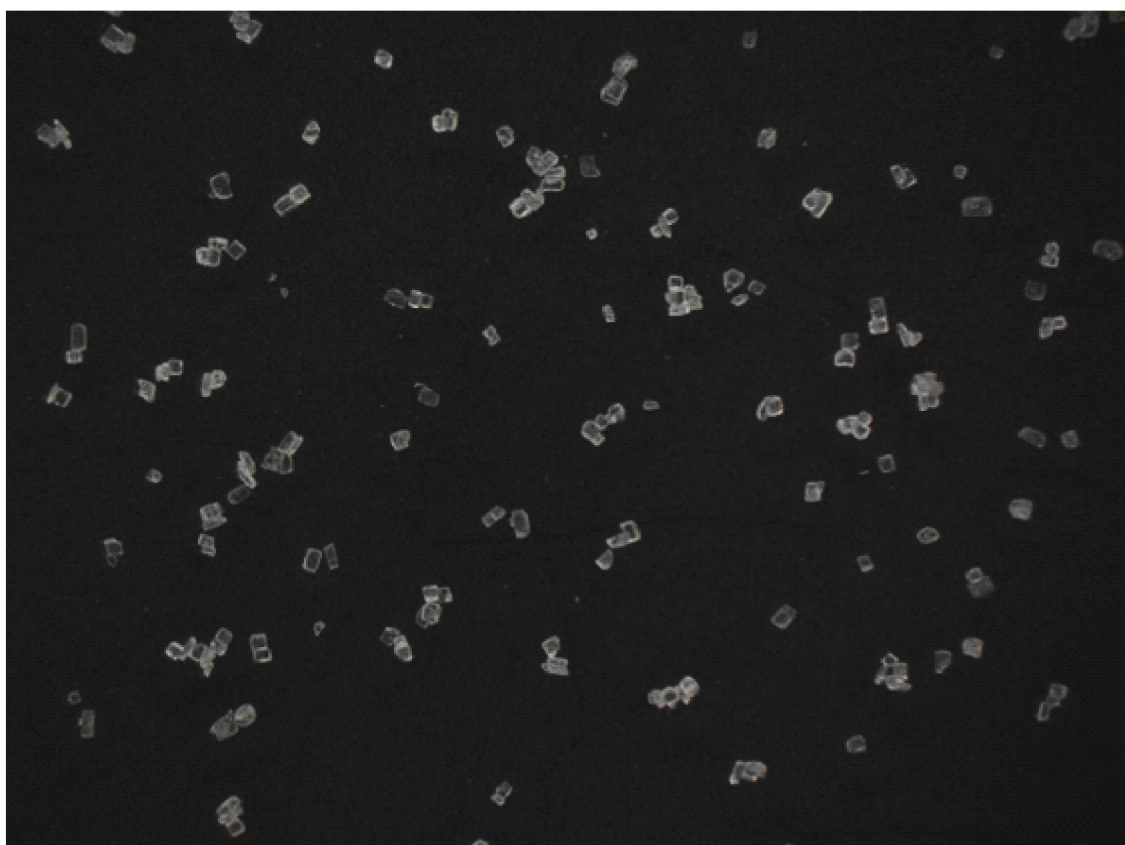


Fig. 5

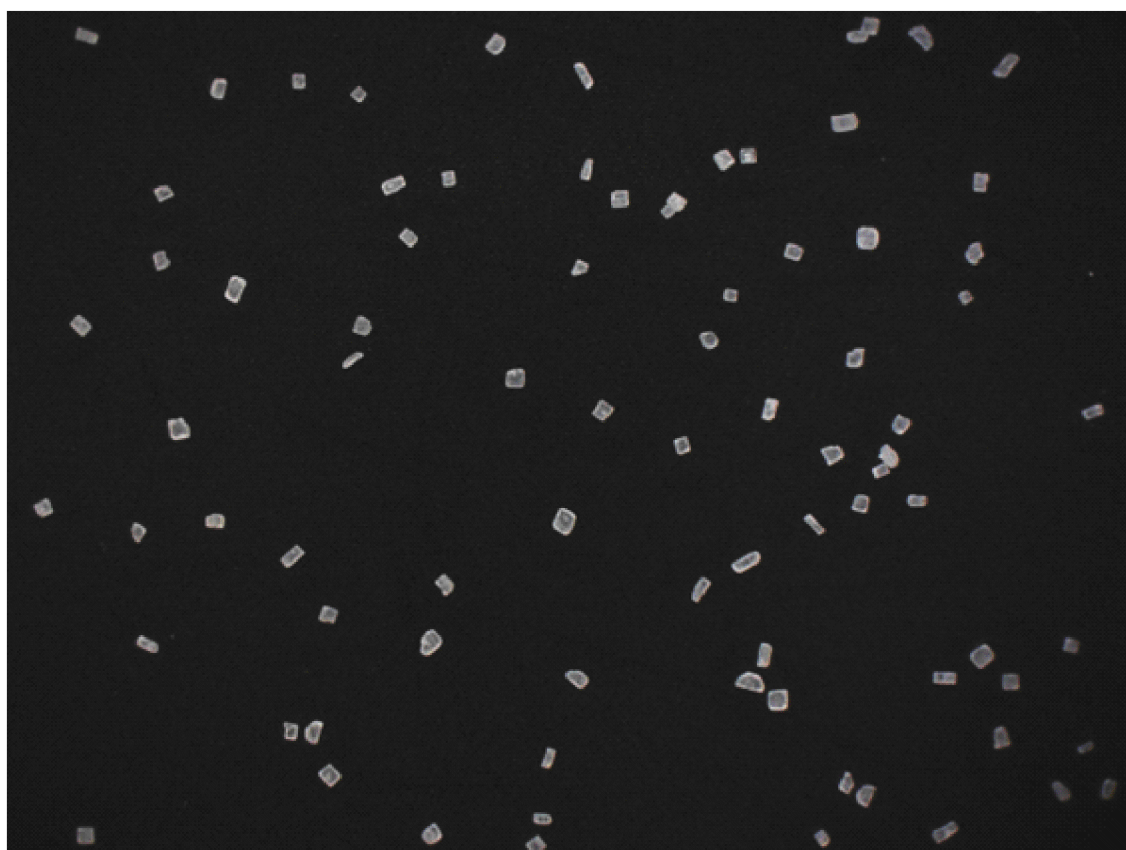


Fig. 6

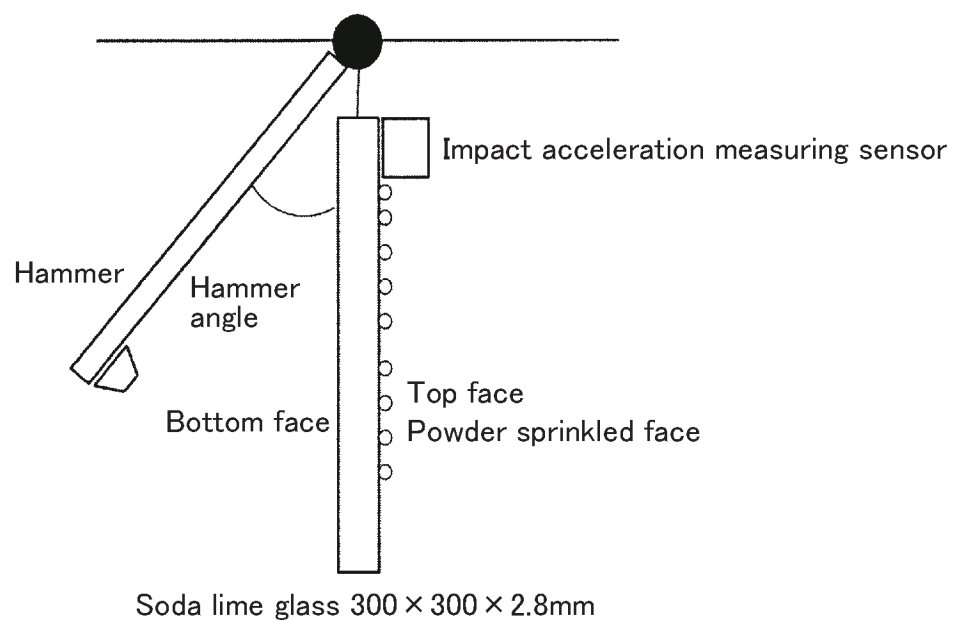


Illustration viewing glass (top face) from the above after sprinkling powder

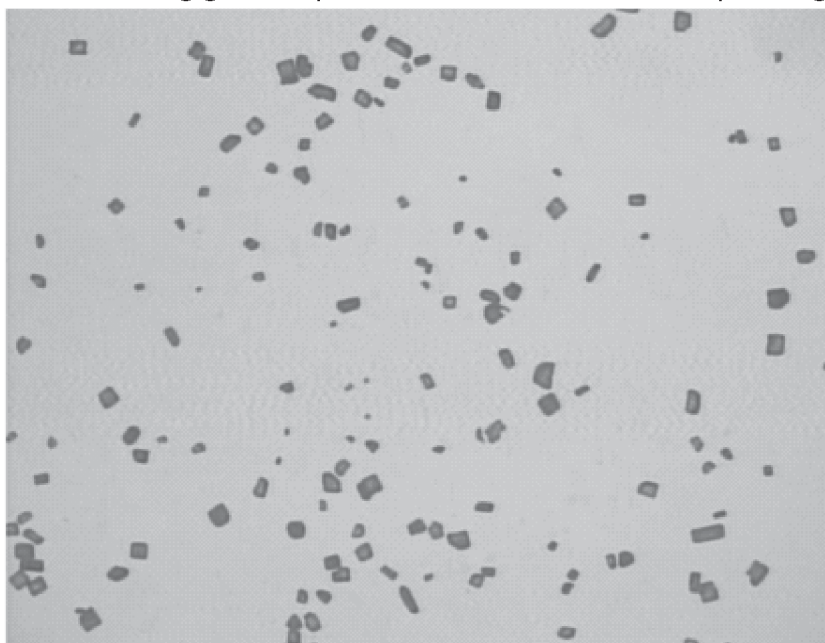
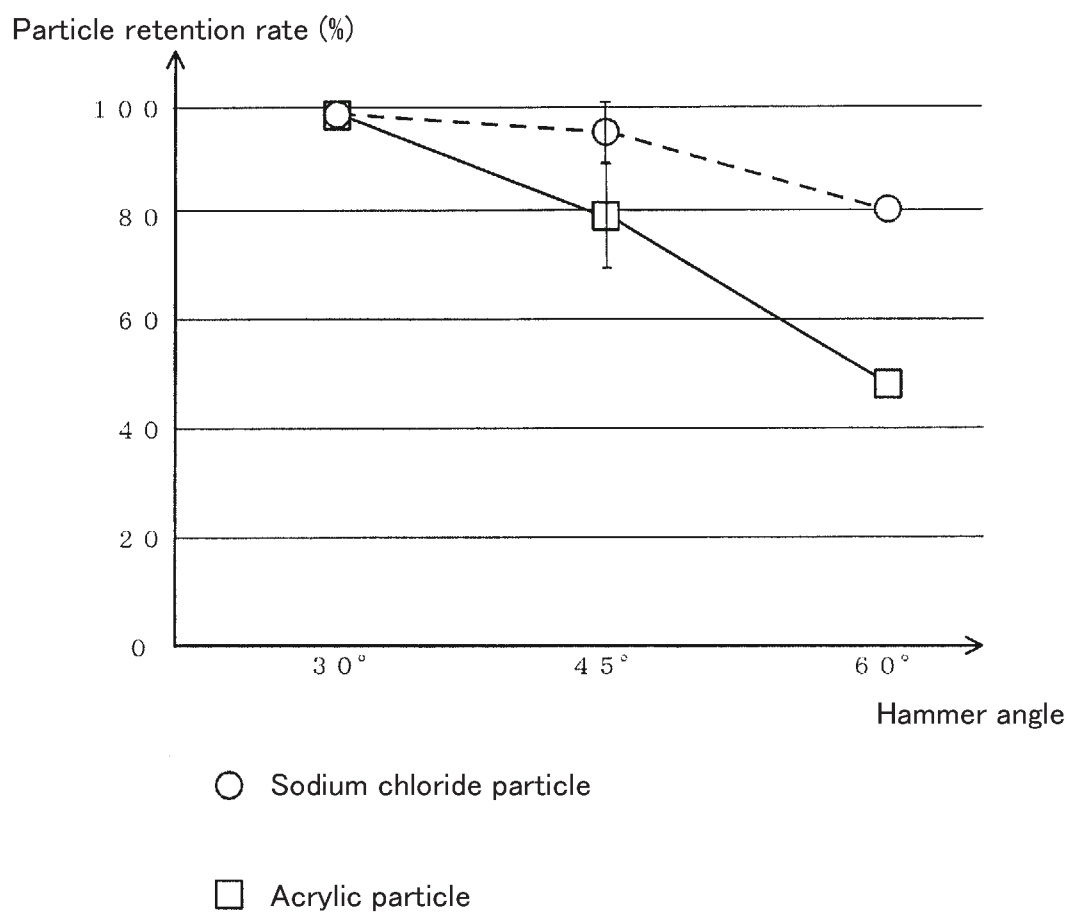


Fig. 7



$$\text{Particle retention rate} = \frac{\text{Total area of adhered particles after impact} \times 100}{\text{Total area of adhered particles before impact}}$$

Fig. 8

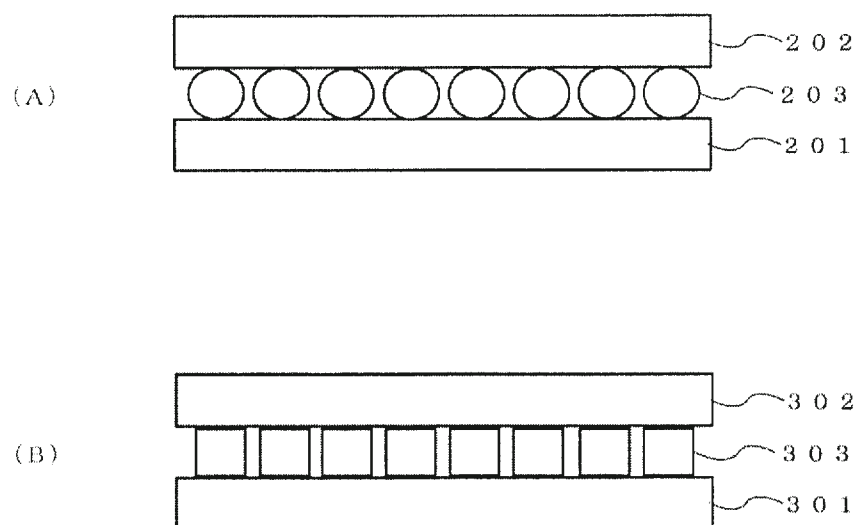


Fig. 9

Sodium chloride particles

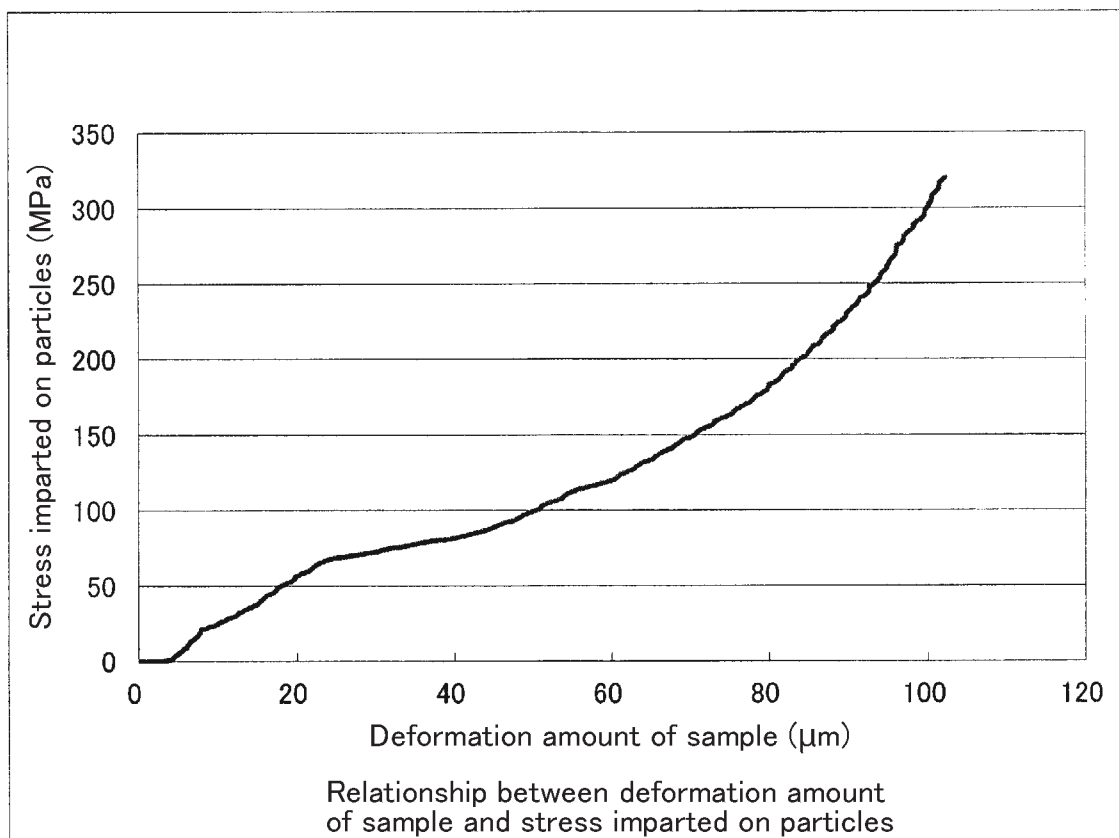


Fig. 10

Acrylic particles

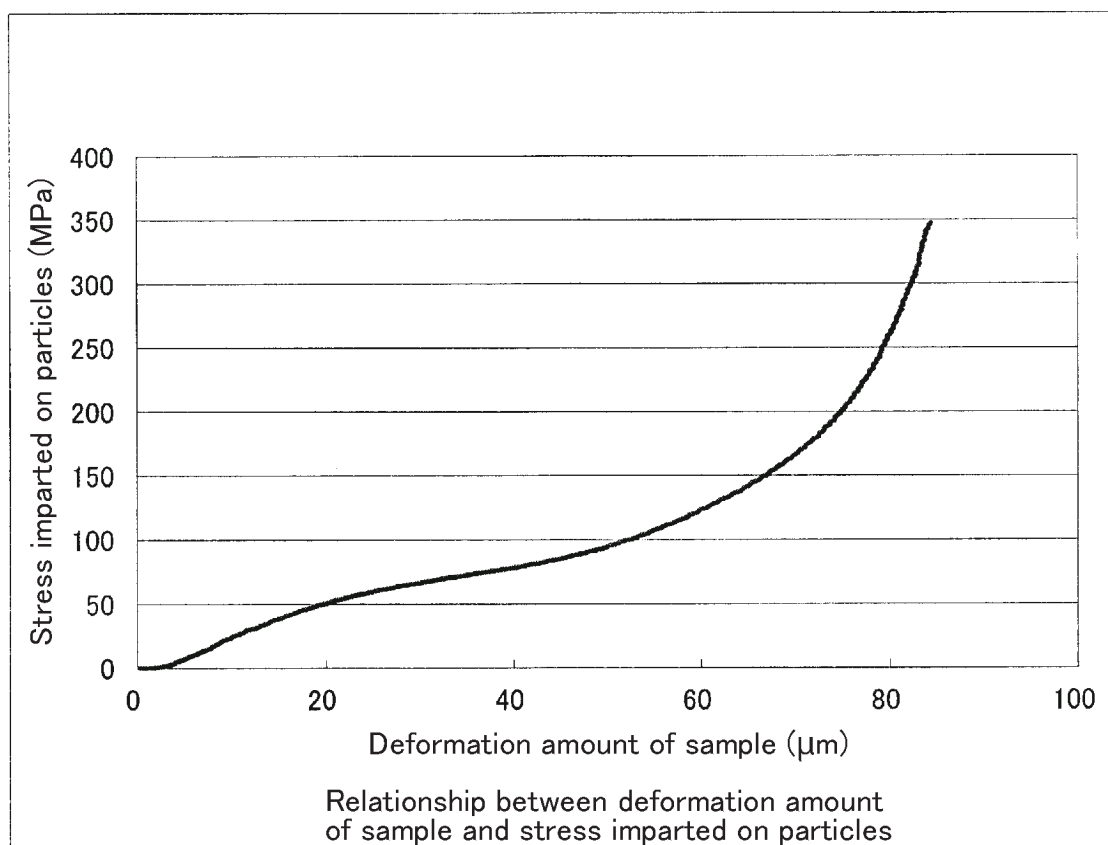
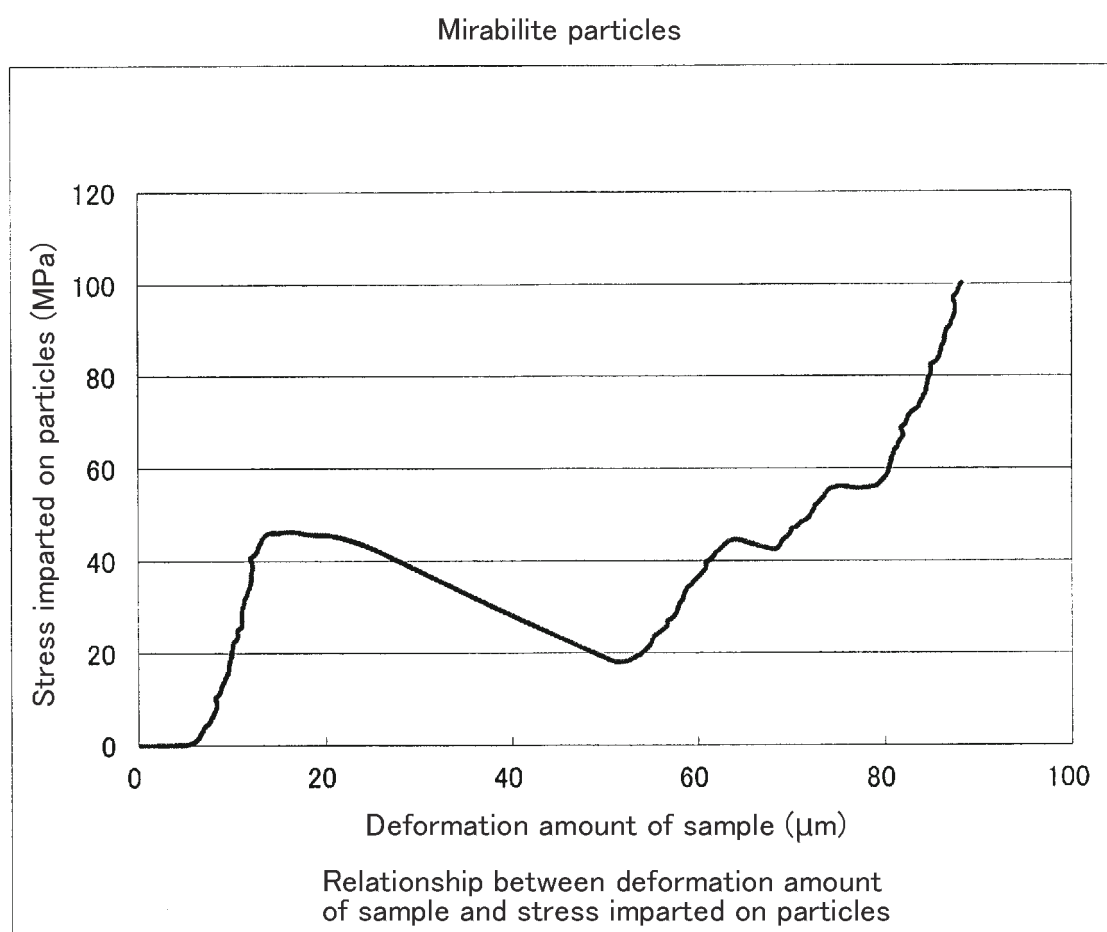


Fig. 11



TRANSLATION

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2025/025689

A. CLASSIFICATION OF SUBJECT MATTER

B65D 85/48(2006.01)i; **B65D 57/00**(2006.01)i

FI: B65D85/48; B65D57/00 B

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B65D85/48; B65D57/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2025
 Registered utility model specifications of Japan 1996-2025
 Published registered utility model applications of Japan 1994-2025

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2006-507036 A (E.I. DU PONT DE NEMOURS AND COMPANY) 02 March 2006 (2006-03-02) paragraph [0092]	1-4
A		5-6
A	JP 2010-202460 A (NIPPON ELECTRIC GLASS CO., LTD.) 16 September 2010 (2010-09-16) entire text	1-6
A	JP 5-294664 A (NIKKA LTD.) 09 November 1993 (1993-11-09) entire text	1-6
A	WO 2015/093029 A1 (NIPPON SHEET GLASS COMPANY, LIMITED) 25 June 2015 (2015-06-25) entire text, all drawings	1-6
A	WO 2022/148947 A1 (MITSUBISHI CHEMICAL UK LIMITED) 14 July 2022 (2022-07-14) entire text, all drawings	1-6

☐ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

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“&” document member of the same patent family

Date of the actual completion of the international search

05 September 2025

Date of mailing of the international search report

22 September 2025

Name and mailing address of the ISA/JP

Japan Patent Office (ISA/JP)
 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915
 Japan

Authorized officer

Telephone No.

TRANSLATION

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2025/025689

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2006-507036 A	02 March 2006	US 2005/0220996 A1 paragraph [0123] WO 2004/016247 A1 KR 10-2005-0062532 A CN 1674874 A	
JP 2010-202460 A	16 September 2010	(Family: none)	
JP 5-294664 A	09 November 1993	(Family: none)	
WO 2015/093029 A1	25 June 2015	US 2016/0318794 A1 entire text, all drawings EP 3085672 A1	
WO 2022/148947 A1	14 July 2022	CN 116670092 A entire text, all drawings	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 10611546 B [0003]