

Translation

Light Scattering Element, specifically for decorative Lighting Purposes.

The invention concerns a light scattering element, specifically for decorative lighting purposes.

Light scattering elements are known in the most diverse shapes. It is desirable with respect to decorative lighting to create by means of refraction- and/or reflection effects highly interesting light patterns, either at the light scattering element itself or at reflecting surfaces, for example at walls or similar. Traditional light scattering elements mostly contain for said purpose reflectors, light conductors or solid bodies for producing the the desired reflection- or refraction effects.

These solid bodies consist mostly of glass, ceramics, plastic material or surface-treated metal and have regular geometric shapes or microscopic irregular structures, for example the shape of regular prisms.

If reflecting effects are to be achieved, then the solid bodies consist either entirely of an appropriate reflecting material or they are coated with a material of this type.

Moreover, attempts have been made to create interesting light effects by using roughened surfaces or by the use of rigid casings filled with ground glass. In order to create refraction effects, these solid bodies must, of course, consist of transparent material.

With this type of known light scattering elements, however, the goal of creating highly interesting light effects is not attainable or can be attained only in unsatisfactory fashion.

Starting from this state of the art, the invention is based on the object of creating a light scattering element, specifically for decorative lighting purposes, by means of which it is possible, in simple fashion, to obtain highly interesting light effects.

The invention solves this object with the characteristics of Patent Claim 1.

The desired interesting lighting effects are produced by providing macroscopic chaotic or quasi-chaotic refraction- and/or reflection planes. The term macroscopic chaotic is employed within the scope of this application in contrast to the known microscopic irregular structures, such as for example roughened surfaces or extremely small irregular bodies, such as ground glass. By "quasi-chaotic" one understands a seemingly irregular structure, even if same should have a certain regularity, which however, is no longer recognized as such by the observer.

According to a specific embodiment of the invention, the light scattering element consists of a with liquid transparent medium filled casing, which is shaped macroscopic chaotically or quasi-chaotically or which has a corresponding irregular outer surface. Such light scattering elements can still be produced with relatively little expenditure if their dimensions are relatively large.

The employment of flexible casings offers the advantage in that with a combination of several of such light scattering elements, they can, for example, be placed in a rigid casing and more easily interlocked and better adapted to a randomly shaped interior of the casing.

As a result, more compact structures are produced which create more interesting light effects.

It is also possible to deform flexible light scattering elements during irradiation or illumination with light and to thus create corresponding effects.

According to one specific embodiment of the invention, the casing consists of a flexible foil, whereby the casing, for example, is not completely filled with the liquid medium and by at least partial removal of air (for example by suction or pressing) from the remaining volume of the casing, prior to its being sealed hermetically, it is possible to produce an irregular deformation of the casing.

In another specific embodiment of the invention, the deformation of the casing can be produced by a mechanical operation, before or after being filled and sealed.

For example, the desired shape can be produced with additional heat supply and simultaneous folding, creasing and crumpling of the casing.

In order for the casing to retain the desired, preferably irregular shape, the thickness of the material of the casing may be selected in such manner that the shape will stay the same despite internal pressure from being filled with liquid. In order to stabilize the shape, the casing can also be coated with a transparent material, for example by pouring transparent polymers over it.

A casing consisting of a foil can be produced by bonding together two or more, preferably planar, foil elements. For example, two or more foils layered on top of each other can be bonded flat at the edges, whereby initially a filling hole is left open for the liquid medium. After filling and sealing of the opening, the thus produced, perhaps multi-layered bag can be mechanically deformed in order to obtain in this manner an element, which achieves the desired refraction- or reflection effects by means of irradiation.

According to another specific embodiment of the invention, a casing designed as flexible foil can also be produced by foil bubble. Hereby a form is mostly used into which a synthetic bubble is blown by generating a sufficiently high internal pressure. This method offers the benefit, in contrast to bonding of several foil elements, that the casing has practically no externally visible seams.

The casing can, for example, also be produced from foil tubes, whereby a tube segment is respectively tightly sealed at both ends.

According to another specific embodiment of the invention, a highly deformed, preferably crinkled foil is arranged within the casing. Said foil is in most instances transparently designed, but can, of course, also consist of a reflective material. If however, interesting refracting effects are to be produced, a transparent foil must be employed whose refraction index is different from the refraction index of the liquid located in the casing. Refracting effects are only produced with the transition of light from one medium with a first refraction index to another medium with a second refraction index, with the latter refraction index being different from the first refraction index. Of course, with such transition, it is also possible for a (partial)-reflection to occur.

The light scattering element according to the invention can also consist of a solid body of one or several flexible materials, whose exterior surface is designed macroscopic chaotically or quasi-chaotically. Suitable materials for said purpose are for example caoutchouc-type silicones, which will still remain flexible at temperatures from -50°C to $+200^{\circ}\text{C}$. Such elements can be produced in simple fashion via casting or extrusion. During this procedure the material may be given an intermediate shape which is being re-shaped after partial hardening. The aforementioned benefits are obtained due to the flexibility of such light scattering elements

According to another specific embodiment of the invention, the casing has a basically smooth exterior surface and the desired interesting refraction- and/or reflection effects are obtained by elements arranged inside the casing. This may involve a highly deformed, preferably crinkled foil and/or one or several light scattering elements according to one of the preceding specific embodiments of the invention.

If inside the essentially smooth casing, additional light scattering elements are arranged with highly deformed covers, then said covers can also be filled with a liquid medium. In that case it is beneficial to fill these additional light scattering elements with liquid media, whose refraction index differs from the refraction index of the fluid medium surrounding these additional light scattering elements. In this manner greater refraction effects are achieved than in a case where only the refraction index of the casing material differs from that of the liquid material. The same applies of course with respect to the refraction index of solid bodies.

In this specific embodiment of the invention the outer casing preferably consists of an essentially rigid material. Thus, there is the benefit of adequate stability with respect to exterior mechanical influences and with respect to the internal pressure of elements or liquids provided therein.

In order to enhance the lighting effects, another highly deformed foil may be provided at the exterior casing. It may, in turn, be designed transparent or at least partially reflecting.

With respect to each of the above explained specific embodiments, additional transparent or reflecting solid bodies may be provided within the casing, which are in suspended equilibrium within the liquid.

A light scattering element can also be produced by the combination of several light scattering elements according to one or several of the above explained specific embodiments. Such combination light scattering element can for example be produced by gluing together or otherwise joining together individual light scattering elements.

In this fashion, the most diverse light scattering elements can be produced from one or several basic modules.

The light scattering element according to the invention can either be designed so that it will only be irradiated by light from a light source located outside the light scattering element, for example a high-performance light source, or, however, in such manner that there is provided within the casing one active or passive light source. In case of an active light source, this may for example involve a low voltage halogen lamp and in case of a passive light source it may involve the ends of light conducting fibers.

In case of an active light source, it may involve a high-performance lamp, for example a high pressure gas discharge lamp.

With a light scattering element which is combined into a spatial structure from several individual light scattering elements such light source can, of course, also be located within the spatial structure, but not within the liquid medium, rather between the outer casings of the individual light scattering elements.

If an active light source is located within a casing filled with a liquid medium, then the liquid can simultaneously serve as cooling medium, by means of which, specifically with respect to high performance lamps, the hitherto unsatisfactorily solved problem of heat dissipation can be brought under control. In this case the liquid medium should have non-conductive properties for reasons of safety.

Additional specific embodiments are apparent from the sub-claims.

The invention is explained below based on specific embodiments represented in the drawings.

Figure 1 shows a first specific embodiment of a light scattering element according to the invention with flexible, highly deformed casing;

Figure 2 shows another specific embodiment according to Figure 1 with additional, inside the casing arranged highly deformed foil,

Figure 3 shows a second specific embodiment of a light scattering element with geometrically formed casing and highly deformed foil arranged inside and

Figure 4 shows a third specific embodiment of a light scattering element according to the invention with rigid geometrically formed casing and additional light scattering elements arranged inside.

The in Fig. 1 represented light scattering element consists of a sealed flexible casing 3, which is filled with a liquid medium, for example water. The sealed casing 3 has a highly irregular shape.

Such light scattering element 1 can for example be produced by foil bubbles, whereby a flexible, transparent material, such as PVC, polyethylene or propylene is being heated and placed in form of a bubble into an appropriate mould and by generating an adequate internal pressure, inflated to a degree until the wall of the bubble is in contact with the interior wall of the mould. After cooling down, the structure, which is flexible because of its suitable thin wall and a suitable material selection, can be taken out of the mould. Subsequently the casing can be totally or partially filled with the liquid medium 5 and the filling opening can be sealed.

The highly irregular exterior shape of the casing 3 of the light scattering element 1 can, however, also be produced in such manner that initially a more or less regular casing is produced by bonding together several foil elements, same are filled only partially with fluid medium and, finally, the remaining gas (air) located therein is at least partially suctioned off. As a result of the partial vacuum, the casing 3 is folded or compressed irregularly.

After at least partially suctioning off the remainder of the gas, the filling opening is, in turn, tightly sealed. Instead of suctioning off the remainder of the gas, it can of course be removed in any other manner, for example by pressing against the partially filled casing.

When selecting the material for the flexible casing and the liquid filler medium, attention must be paid to the requirement for tightness. For example, commercial foils made of PVC, PE, PP or polyamide are not suitable for filling with water, since adequate water tightness and vapor tightness is not attainable. Adequate tightness can be achieved by providing barriers on the foil surface, for example by application of an alkyl-chlorosilane mixture.

Higher molecular substances are also suitable as liquid filling medium, for example oils of all types whose molecule size is greater than the pore size of the foils. A barrier coating is not needed in that case.

The light scattering element can, in addition, be surrounded for protection against mechanical damage with a suitably stable protective casing (not shown). Same can be produced for example by pouring transparent polymers over casing 3. Preferably such materials are employed which will retain sufficient flexibility after hardening.

The light scattering element represented in Fig. 1 could exist in the same shape also as solid body, preferably of flexible material. For that purpose, caoutchouc-type silicones are suitable, which will remain elastic in temperatures from -50°C to $+200^{\circ}\text{C}$. Because of their excellent chemical stability, they may also be employed in light-reactive processes, for which glass is not suitable, for example in the photo-decomposition of acids, which attack glass.

Such light scattering elements without casing may be produced by suitable moulds, whereby after casting or extrusion, subsequent shaping may take place.

The in Figure 2 represented light scattering element 10 again has a highly irregularly shaped outer form 3, which may be produced in the same fashion as previously described for the light scattering element 1 according to Figure 1.

The light scattering element 10 is again filled with a transparent liquid medium 5. Additionally, there is provided inside the casing 3 a highly irregularly shaped, for example crinkled transparent foil 7, which generates additional fractioning- or reflection effects during irradiation with light of the light scattering element 10.

The in Figure 3 represented additional specific embodiment of a light scattering element 20 according to the invention has, again, a sealed casing 3, which, however, in contrast to the specific embodiments according to Fig. 1 and 2, has an essentially smooth - - i.e. not creased or crinkled outer surface. Such casing 3 can be produced for example by foil bubble, whereby a correspondingly designed mould is employed. It is, however, also possible to produce such casing by bonding together several individual foil elements 3'.

If a mechanically stable or rigid casing is wanted, it can, of course, also be produced by gluing together individual, appropriately shaped plates or blown or otherwise shaped material (for example plastic material, glass).

Inside casing 3 of the light scattering element 20 is provided, the same as with respect to specific embodiment according to Fig. 2, a highly deformed Foil 7. Said foil results in the desired lighting effects during irradiation with light of the light scattering element.

The light scattering element 30 represented in Fig. 4 has a rigid outer casing 3, which may be designed, for example, as depicted in Fig. 4, in form of a pyramid. The rigid casing 3, which has sufficient stability against exterior mechanical influences, may for example be made of acrylic glass or any other transparent material and may, of course, have any random shape.

Within the rigid casing 3 is arranged a multiplicity of individual light scattering elements, which, in turn, may be designed the same as light scattering elements 1, 10 or 20 according to Fig. 1 to 3. In this manner several or a multiplicity of such light scattering elements may be combined into a larger light scattering element with a given spatial structure.

Based on the flexibility of each individual light scattering element, these may adapt themselves without problem to randomly formed rigid casings and may be densely packed inside the casing, as a result of which the desired interesting light effects can be attained.

The individual light scattering elements may, perhaps, also placed inside the rigid casing by means of mechanical pressure and for improvement of flexibility at a higher temperature in order to achieve better adjustment to the shape of the rigid casing and for more densely arranged packing.

The combining of such individual light scattering elements 1, 10 or 20 may, of course, also be done in such manner that they are united into the desired structure without exterior casing 3, for example by being glued together.

The exterior casing 3 of the light scattering element 30 according to Fig. 4 may, in turn, be filled with a liquid medium 5. As is schematically depicted in Fig. 4, within the exterior sealed casing 3 may be provided an active or passive light source 9. This may involve for example in case of an active light source, a low-voltage halogen lamp and in case of a passive light source, for example the ends of light conducting fibers.

Of course, such type of light source may, however, be provided not only with respect to the specific embodiment according to Figure 4, but for any chosen specific embodiment of a light scattering element according to the invention within the casing 3. If an active light source is to be employed for light source 9, it must, of course, be designed liquid-tight. Thus, traditional illumination bodies used for underwater lighting may, for example, be employed. The liquid medium surrounding such active light source should be electrically non-conductive in order to avoid, in case of defect, all danger to persons handling such light scattering elements.

With the use of active light sources within a casing 3 filled with liquid medium 5, there results the benefit of extremely space-efficient construction design, since the liquid medium can simultaneously serve as cooling medium for the dissipation of active light source energy.

In order to generate the desired lighting effects, the transparent liquid medium 5 may of course also be colored. In each instance the refractive index of the liquid medium 5 and the index of the crumpled foils 7 provided therein should differ from each other since otherwise, as a result of full immersion of the crumpled foils, their refractive or reflecting effect is being suppressed. Different refractive indices may be relinquished if the color of the liquid medium or of the exterior casing 3 of the light scattering element is different from the color of the crumpled foil 7.

The same applies in the case where several or a multiplicity of individual light scattering elements 1, 10 or 20 according to Fig. 4 have been combined into one larger spatial structure. If that structure is additionally surrounded by a transparent liquid medium 5, then the desired refraction- or reflection effects can also be produced in that the liquid medium within the individual light scattering elements 1, 10 or 20 has a different refraction index from the liquid medium surrounding the individual light scattering elements.

Other interesting effects may result if the light scattering element is not filled with a homogeneous liquid medium but with different media which are not mixable with each other. This leads to pronounced phase limitations, whereby the different refractive indices of the fluid media produce, in turn, corresponding refractive or reflection effects.

It is mostly with large illumination surfaces that reflection effects may be desired at the casing 3 of an individual light scattering element 1, 10 or 20 or at the outer casing 3 of a spatial arrangement of individual light scattering elements 1, 10, 20. This applies with respect to the light of a external light source for the irradiation of the light scattering element as well as for incoming day light or other outside light. To that end, all casings or individual casings 3 may have a complete or partial reflective coating. This may be accomplished for example by sputter-spraying or vapor-spraying the exterior or the interior side of the casings.

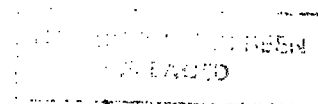
The possibility also exists of coating the casing with a one-sided reflective coating, whereby the incident light from the outside on the light scattering element is being reflected and, in spite of that, light from the interior side of the casing can be transmitted toward the outside.



P a t e n t C l a i m s

1. Light Scattering Element, specifically for decorative lighting purposes,
characterized in that the light scattering element has macroscopic
chaotically or quasi-chaotically formed reflection planes.
2. Light Scattering Element according to Claim 1,
characterized in that the light scattering element has a closed, at least
partially with transparent liquid medium (5) filled transparent casing (3),
which is shaped macroscopic chaotically or quasi-chaotically.
3. Light Scattering Element according to Claim 2,
characterized in that the casing is flexible.
4. Light Scattering Element according to Claim 3,
characterized in that the casing (3) consists of a flexible foil.
5. Light Scattering Element according to Claim 4,
characterized in that the casing (3) designed as flexible foil, is deformed
by incomplete filling with liquid medium (5) and at least partial removal
of the remainder of the gas prior to sealing of the casing (3).
6. Light Scattering Element according to Claim 4,
characterized in that the casing (3) designed as flexible foil, is deformed
by means of mechanical influences, preferably creasing, crumpling or
similar.

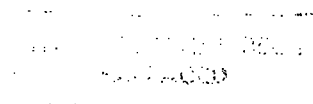
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7. Light Scattering Element according to one of Claims 4 to 6,
characterized in that the casing (3) designed as flexible foil is produced by bonding together two or more, preferably plane, foil elements (3').
8. Light Scattering Element according to one of Claims 4 to 6,
characterized in that the casing (3) designed as flexible foil is produced by means of foil bubbles.
9. Light Scattering Element according to one of Claims 2 to 8,
characterized in that inside casing (3) is arranged a highly deformed, preferably crumpled foil (7).
10. Light Scattering Element according to one of Claims 2 to 9,
characterized in that inside casing (3) are provided transparent or reflecting solid bodies, which are in suspended equilibrium in the liquid.
11. Light Scattering Element according to Claim 1,
characterized in that the Light Scattering Element consists of one or several transparent highly viscous or flexible materials, whereby the outer surface of the Light Scattering Element has a macroscopic chaotic or quasi-chaotic design.
12. Light Scattering Element according to Claim 1,
characterized in that the Light Scattering Element has a casing (3) with essentially smooth exterior surface and that inside the casing (3) are arranged a highly deformed, preferably crumpled foil (7) and/or one or several Light Scattering Elements (1, 10, 20) according to one of Claims 1 to 11.

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13. Light Scattering Element according to Claim 12,
characterized in that the casing (3) consists of essentially rigid material.
14. Light Scattering Element according to Claim 12 or 13,
characterized in that inside casing (3) is provided an active or a passive light source (9).
15. Light Scattering Element according to Claim 14,
characterized in that the casing (3) is filled, at least in part, with a liquid medium (5) which simultaneously serves as cooling medium for an active light source (9).

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