Title: RESIN COMPOSITION SUITABLE FOR DIRECT EXTRUSION OF SHEETS WITH SURFACE STRUCTURE TO ELIMINATE NEWTON'S RINGS

Abstract: The present invention provides a resin composition for producing extrusion products like sheets that generate no or minimum Newton's rings, comprising: 90 wt% to 99.99 wt% of resin as base resin, and 0.01 wt% to 10 wt% of cross-linked resin beads, based on the total weight of the composition. The invention also provides a method for producing extrusion products that generate no or minimum Newton's rings, and an extrusion product. The present invention provides a simple and economic technical solution of making extrusion products with no or minimum Newton's rings by extrusion directly without using special molds.
Resin composition suitable for direct extrusion of sheets with surface structure to eliminate Newton's rings

Technical Field
The present invention relates to a new resin composition suitable for direct extrusion of sheets with surface structure to eliminate Newton’s rings.

Background art
Transparent sheets are used in lighting devices, panels, and the like. In some cases, for example, in some lighting devices, transparent sheets used should have minimum Newton's rings phenomenon.

However, Newton's rings occur in sheets made by conventional methods. Newton's rings occur when light is reflected by a spherical surface and an adjacent flat surface with an air film in between. Very often, two flat surfaces with intimate contact also form Newton's rings if one of the surfaces has deformation. One way to prevent Newton's rings from occurring is to make one of the two surfaces rough. In order to achieve certain optical properties, the transmission loss by making the surface rough should be minimized. Extruded or injection molded sheets with surface structure can be used for this purpose. However, the production complexity and the transmission loss are usually high. Density of the surface structure can only be changed by changing the design of the roller (for extrusion) or the mold (for injection molding).

It is desirable to provide sheets which will generate minimum Newton's rings.

Summary of the invention
The objective of the present invention is to overcome as least part of the defects of the prior art. The present invention therefore provides a composition, particularly an acrylic resin composition, which is suitable to produce extrusion products for example, sheets, by direct extrusion with surface structure which has reduced or no Newton's rings.
phenomenon. The composition comprises a resin as matrix and cross-linked resin beads.

According to the present invention, the resin composition comprises:
- 90-99.99 wt% of resin as base resin, and
- 0.01-10 wt% of cross-linked resin beads, based on the total weight of the composition.

The resin of the invention can be any materials suitable for extrusion process and purpose of the extruded products. Preferably, the resin is acrylic resin. Non-limiting examples of acrylic resin include polymethyl methacrylate (PMMA).

The base resin can also be a mixture. For example, additives can be added into the base resin. For example, if impact strength is specially required for base resin, impact modifier can be added.

The resin composition can further comprise other suitable components in the art. Alternatively, the resin composition consists of base resin and cross-linked resin beads.

Although refractive indices have nothing to do with Newton's ring, in some embodiments, the refractive indices of the base resin and the beads are the same, so that a transparent extrusion product can be obtained. More preferably, the resins of both base resin and resin beads are transparent.

In some embodiments, the refractive indices of the base resin and the beads are the same or very close, e.g. less than 5 %, preferably 4 %, 3 %, 2 %, 1 %, 0.5 %, 0.2 %, or 0.1 % difference.

In some embodiments, the refractive indices of the base resin and the beads are different.

The materials of base resin and resin beads can be either different or the same. In some embodiments, the material of the base resin is the same as
that of the beads; preferably, the material of base resin and/or resin beads is polymethyl methacrylate (PMMA).

The resin composition comprises preferably 0.02-10 wt%, 0.05-10 wt%, 0.1-10 wt%, 0.2-10 wt%, 0.5-10 wt%, 0.5-8 wt%, 0.5-6 wt%, 0.5-5 wt%, 0.5-4 wt%, 0.4-5 wt%, 0.5-4 wt% of cross-linked resin beads based on the total weight of the composition. In one embodiment, the acrylic resin composition comprises 0.02-10 wt% of cross-linked acrylic resin beads; in another embodiment, the acrylic resin composition comprises 0.5 wt% of cross-linked acrylic resin beads; in one further embodiment, the acrylic resin composition comprises 3 wt% of cross-linked acrylic resin beads; in one specific embodiment, the acrylic resin composition comprises 4 wt% of cross-linked acrylic resin beads.

The mean particle size of the resin beads is preferably from 5 μm to 200 μm, more preferably from 20 μm to 100 μm.

According to the invention, the resin beads should be cross-linked. If the resin beads are not cross-linked, the beads are easy to be overly deformed after the extrusion process and thus the resulting sheets would possibly generate Newton's rings. In one embodiment, the crosslinking degree of the resin beads is 2%.

In addition to sheet, the extrusion products can be of any shape, such as film, plate, or profile, etc.

The present invention also provides a method for producing extrusion products that generate no or minimum Newton's rings by extrusion, comprising the step of extruding the resin composition of the present invention. The extrusion process can be direct extrusion and an extrusion process of the prior art.

The present invention further provides a method for producing extrusion products that generate no or minimum Newton's rings, comprising:
- mixing a composition comprising 90-99.99 wt% of resin as base resin, and 0.01-10 wt% of cross-linked resin beads, based on the total weight of the composition, and
- extruding the composition.

The extrusion products produced according to the method of the present invention have a surface structure (see, e.g. Figure 1) that eliminates Newton's rings.

The present invention further provides use of the resin composition of the present invention in producing extrusion products that generate no or minimum Newton's rings.

The present invention further provides an extrusion product that generates no or minimum Newton's rings, wherein the extrusion product is made from the resin composition of the present invention, or is made according to the method for producing extrusion products of the present invention. The extrusion product is preferably transparent.

The present invention further provides an article comprising an extrusion product that generates no or minimum Newton's rings of the present invention. The article includes but is not limited to lighting devices. In such embodiments, the extrusion products are parts of the lighting devices, such as a cover for panel lighting. The article can be made by e.g., conventional methods with the extrusion product of the present invention as a part.

Therefore, the present invention provides a simple and economic technical solution of making extrusion products like sheet without or with minimum Newton's rings by extrusion directly without using special molds. By using the resin composition of the invention, extrusion product with surface structure can be directly produced with normal extrusion process, for instance, a conventional sheet extrusion line, comprising of extrusion system, sheet die, calender rolls system, and pull-roll system etc. Rollers normally required in prior art for bringing surface structure on the sheet are not needed. Another major advantage of the invention is, that it is easy to process. The density of the surface structure can be simply tuned by changing the loading of the cross-linked acrylic resin beads. In addition, the resin beads essentially have no effect to the rheology, mechanical properties, thermal properties of the base
resin. Other advantages of the present invention would be apparent for a person skilled in the art upon reading the specification.

**Brief Description of Drawings**

Figure 1 is a magnified photograph taken under an optical microscope, showing the surface structure of the extruded sheet of Example 3.

**Detailed description of the invention**

The invention is now described in detail by the following examples. The scope of the invention should not be limited to the embodiments of the examples.

**Example 1**

The composition of example 1 comprised of 99.5 % PMMA (PLEXIGLAS® 8N clear) and 0.5 % cross-linked PMMA beads (mean particle size 46 μη). 2.5mm thick sheet (A) was extruded on a 30 mm single-screw extruder with a free forming table with barrel temperature from 210 °C to 260 °C and die temperature of 200 °C. The crosslinking degree of the resin beads was 2 %.

The sheet (A) was transparent and the light transmission was 91.9 %.

Light transmission was measured on ColorEye 7000A (Illuminant: D65/10) according to ISO 13468-2.

**Testing for Newton's rings:**

100 % PMMA (PLEXIGLAS® 8N clear) was used to extrude a 2.5 mm thick flat PMMA sheet (B).

A 2.5 mm thick sheet (A) of example 1 was placed on a 2.5 mm flat PMMA sheet (B). When deforming the sheet (A) of example 1 by exerting a force on part of the surface of the sheet (A), no Newton's rings were observed.

Examples 2-4
2.5 mm thick sheets (A) of examples 2-4 were prepared by the same method as described in example 1 with the loading of beads as shown in Table 1. The sheets (A) of examples 2-4 were transparent.

<table>
<thead>
<tr>
<th>Examples</th>
<th>Loading of beads (wt%)</th>
<th>Loading of PMMA (wt%)</th>
<th>Transmission at 2.5 mm (%)</th>
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<tr>
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<td>99.5</td>
<td>91.9</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>99</td>
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<td>3</td>
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<td>4</td>
<td>4</td>
<td>96</td>
<td>90.2</td>
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</table>

Sheets (A) of examples 2-4 were tested in the same way as sheet (A) in example 1, no Newton's rings were observed.

**Comparative example 1**

Using 100 % PMMA (PLEXIGLAS® 8N clear), a 2.5 mm thick sheet (A) was extruded on a 30 mm single-screw extruder with a free forming table with barrel temperature from 210 °C to 260 °C and die temperature of 200 °C.

The light transmission of a 2.5 mm thick sheet (A) extruded from PLEXIGLAS® 8N clear was 92 %. Light transmission was measured on ColorEye 7000A (Illuminant: D65/100) according to ISO 13468-2.

A 2.5 mm thick sheet (A) of comparative example 1 was placed on a flat PMMA sheet (B). When deforming the sheet (A) of comparative example 1 by exerting a force on part of surface of the sheet (A) of comparative example 1, Newton's rings were clearly observed.

As used herein, terms such as "comprise(s)" and the like as used herein are open terms meaning 'including at least' unless otherwise specifically noted.
All references, tests, standards, documents, publications, etc. mentioned herein are incorporated herein by reference. Where a numerical limit or range is stated, the endpoints are included. Also, all values and subranges within a numerical limit or range are specifically included as if explicitly written out.

The above description is presented to enable a person skilled in the art to make and use the invention, and is provided in the context of a particular application and its requirements. Various modifications to the preferred embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments and applications without departing from the spirit and scope of the invention. Thus, this invention is not intended to be limited to the embodiments shown, but is to be accorded the widest scope consistent with the principles and features disclosed herein. In this regard, certain embodiments within the invention may not show every benefit of the invention, considered broadly.
Claims

1. A resin composition comprising:
   - 90 wt% to 99.99 wt% of resin as base resin, and
   - 0.01 wt% to 10 wt% of cross-linked resin beads, based on the total weight of the composition.

2. The resin composition of claim 1, wherein the resin is acrylic resin, preferably polymethyl methacrylate.

3. The resin composition of claim 1, wherein the refractive indices of the base resin and the beads are the same, preferably the materials of base resin and resin beads are the same.

4. The resin composition of claim 1, wherein the resin composition comprises 0.02 wt%-10 wt%, 0.05 wt%-10 wt%, 0.1 wt%-10 wt%, 0.2 wt%-10 wt%, 0.5 wt%-10 wt%, 0.5 wt%-8 wt%, 0.5 wt%-6 wt%, 0.5 wt%-5 wt%, 0.5 wt%-4 wt%, 0.4 wt%-5 wt%, or 1 wt%-5 wt% of cross-linked resin beads based on the total weight of the composition.

5. The resin composition of claim 1, wherein the mean particle size of the resin beads is from 5μm to 200μm, preferably from 20μm to 100μm.

6. A method for producing extrusion products that generate no or minimum Newton's rings by direct extrusion, comprising the step of extruding the resin composition according to any one of claims 1-5.

7. A method for producing extrusion products that generate no or minimum Newton's rings, comprising:
   - mixing a composition comprising 90 wt% to 99.99 wt% of resin as base resin, and 0.01 wt% to 10 wt% of cross-linked resin beads, based on the total weight of the composition, and
   - extruding the composition.

8. Use of the resin composition according to any one of claims 1-5 in producing extrusion products that generate no or minimum Newton's rings.
9. An extrusion product that generates no or minimum Newton's rings, wherein the extrusion product is made from the resin composition according to any one of claims 1-5, or is made according to the method of claims 6 or 7.

10. An article comprising an extrusion product that generates no or minimum Newton's rings of claim 9.
Fig. 1
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

C08L 33/10(2006.01)i; C08J 5/18(2006.01)i

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)

C08L; C08J; C08L33; C08J5

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

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

CPRSABS,CNTXT, CNKI, WPODOC, bas+, resin?, +methacrylate, polymethyl w methacrylate, crosslink+, bead+, particle, newton+ ring, acrylic, polymethyl, extrud+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:
  
  **A** document defining the general state of the art which is not considered to be of particular relevance
  
  **E** earlier application or patent but published on or after the international filing date
  
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  **X** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  
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  **&** document member of the same patent family

Date of the actual completion of the international search

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Date of mailing of the international search report

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Telephone No. (86-10)62084415

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