Title: SOUND ABSORBING POLYPROPYLENE RESIN COMPOSITION CONTAINING NANOCLAY

Abstract: Disclosed herein is a polypropylene resin composition containing nano-clay. More specifically, the present invention relates to a sound absorbing polypropylene composition comprising polypropylene resin, mixture of talc and barium sulfate in which the ratio of talc/barium sulfate is 1:9 – 9:1, Nano-Clay, and selectively agents enhancing compatibility. Using the polypropylene resin composition of the present invention, there may be provided sound-absorbing pipe used in building houses and apartments because the composition has heat resistance, impact resistance, and sound absorbing ability.
SOUND ABSORBING POLYPROPYLENE RESIN COMPOSITION CONTAINING NANOCLAY

Technical Field

The present invention relates to a polypropylene resin composition with excellent sound absorption properties, and more particularly to a polypropylene resin composition suitable for use in wastewater discharge pipes which comprises a polypropylene resin as a base resin, a mixture of talc and barium sulfate as sound-absorbing components, and nano-clay (nanometer-sized clay). The polypropylene resin composition of the present invention exhibits improved sound absorption properties while maintaining excellent impact resistance and heat resistance intrinsic to the polypropylene resin.

Background Art

Polypropylene resin is a kind of multipurpose plastic which can be widely used in a variety of applications, e.g., automobile parts and electric components, because of its excellent processability, chemical resistance, weather resistance, foldability, and the like. Polypropylene resin is commonly used in the form of an injection-molded article, a film or a blow-molded article. In recent years, as new grades of polypropylene resins having composite functions of flame retardance, heat resistance, rigidity, impact resistance and long-term weather resistance have appeared, a number of attempts have been made to use them in novel applications, particularly, construction and industrial materials. Due to recent diversification of living environments, there has been a strong tendency for comfortable and luxurious circumstances of residence. In particular, composite functions, including convenience, as well as environmental factors such as low pollution and noise, have been focused in general houses and apartment complexes. From the viewpoint of the environment, people have a desire to live in a naturally friendly place surrounded by clean air, pure water, dense forest and low noise.

Noise transmission between floors in apartment complexes causes trouble between neighbors. Such noises are mainly created because of small concrete thickness between floors, wastewater discharge pipes such as pipes laid in bathrooms, drain boards and toilets, riser pipes and underground transverse pipes.

Polyvinyl chloride (PVC) pipes for hard discharge water pipes are widely used
as wastewater discharge pipes in apartment construction, and are largely classified into two types, i.e. VG1 and VG2. These types of PVC pipes are different from each other in several points, which are price-determining factors. Since the VG1-type PVC pipes are large in thickness, heavy in weight and expensive, the VG2-type PVC pipes are predominantly used as wastewater discharge pipes.

PVC resins widely used for pipe materials for construction have many disadvantages in terms of unsatisfactory sound-absorbing and sound-proofing effects and poor physical properties. Specifically, PVC resins are known to have a Vicat softening point of about 70°C from the viewpoint of heat resistance, an Izod impact strength (room temperature, Notch) of 2.5 kg·cm/cm, and a flexural modulus of elasticity (kg/cm²) of about 28,000 in terms of rigidity.

To solve these problems of PVC resins, there have been some suggestions, e.g., addition of a glass fiber as a sound-absorbing and sound-proofing material, and introduction of spin-structured or 3-layer wall-structured PVC pipes (Japanese Patent Laid-open Nos. Hei 5-272691 and Hei 6-174175). However, despite increased construction costs, improvement in noise-blocking effects, heat resistance and impact resistance are still insufficient. On the other hand, cast iron pipes have disadvantages in terms of difficult construction, poor durability and high price.

Korean Patent No. 1999-000188 reports the addition of 50~75% of barium sulfate as an inorganic filler to a polypropylene copolymer. However, this composition is difficult to mold into pipes due to high hygroscopicity of the inorganic filler and has a very high specific gravity due to the presence of a large amount of the inorganic filler. Further, despite the presence of a large amount of the inorganic filler, the composition exhibits a low impact strength, bad heat resistance and a low hardness. Accordingly, pipes manufactured from the composition have disadvantages that they are relatively easily deformed and are expensive.

The deterioration in the mechanical properties and heat resistance of the polyolefin resin is due to the inorganic filler being simply incorporated into the resin using mechanical means.

Thus, there exists a need for a pipe molding material having excellent sound absorption properties, impact resistance and heat resistance while solving noise problem of conventional PVC pipes and reducing the price of conventional cast iron pipes. There also exists a need for a pipe molding material which is environmentally friendly and easy to recycle.
Disclosure of the Invention

Therefore, the present invention has been made in view of the above problems, and a feature of the present invention is to provide a polypropylene resin composition for highly impact-resistant, heat-resistant and sound-absorbing pipes, comprising a polypropylene resin, a mixture of two sound-absorbing components in an appropriate mixing ratio, and Nano-Clay M/B.

Since the polypropylene resin composition including an inorganic material such as a layered clay mineral is formed into a master batch, it exhibits considerably good characteristics, compared to those manufactured in a simple mixing manner using mechanical means.

In accordance with the feature of the present invention, there is provided a polypropylene resin composition, comprising (A) 55~70% by weight of a polypropylene resin, (B) 15~50% by weight of a mixture of talc and barium sulfate, the mixing weight ratio of talc to barium sulfate being in the range of 1:9~9:1, and (C) 0.01~15% by weight of nano-clay.

If necessary, the polypropylene resin composition of the present invention further comprises (D) 0.01~5% by weight of a compatibilizer.

Hereinafter, the polypropylene resin composition according to the present invention will be explained in more detail based on the respective constituent components.

The polypropylene resin (A) contained in the composition of the present invention includes syndiotactic homopolypropylenes, isotactic homopolypropylenes, propylene-ethylene block copolymers and propylene-ethylene random copolymers. Propylene-ethylene block copolymers and propylene-ethylene random copolymers are preferred. Among the isotactic homopolypropylenes, it is preferred to use crystalline polypropylenes having an isotactic pentad fraction of 0.80~0.99 and preferably 0.90~0.99, identified through $^{13}$C-NMR (nuclear magnetic resonance) spectrum. Among the propylene-ethylene random copolymers, random copolymers having an Izod impact strength at room temperature of 2~10 kg-cm/cm are preferably used in view of mechanical properties and extrusion processability. Among the propylene-ethylene block copolymers, it is preferred to use impact copolymers having an Izod impact strength at room temperature of 11 kg-cm/cm or more, and more preferably 50 kg-cm/cm or more considering mechanical properties, extrusion processability, moldability, impact resistance and the like. The polypropylene resin used in the present invention must have a melt index (ASTM D1238: 230°C, load of 2.16kg) of
0.1~60 g/10min., irregardless of the kind of the resin. When the melt index of the polypropylene resin is less than 0.1 g/10min., the injection moldability of the resin composition is poor and appearance defects such as flow marks are observed. On the other hand, when the melt index of the polypropylene resin exceeds 60 g/10min., the injection moldability of the resin composition is excellent, but the extrusion moldability is poor and the impact resistance is drastically deteriorated.

The content of the component (A) in the resin composition of the present invention is preferably adjusted within the range of 55~70% by weight. When the component (A) is present in an amount of less than 55% by weight, it is difficult to mold the composition into a desired molded article. Whereas, when the component (A) is present in an amount exceeding 70% by weight, the content of the component (B) is relatively low, and thus the sound absorption properties are not further improved and the heat resistance and impact resistance are inferior.

As the component (B) contained in the resin composition of the present invention, a mixture of talc and barium sulfate is used. At this time, the mixing weight ratio of talc and barium sulfate is in the range of 1:9~9:1. According to the present invention, the content and the mixing ratio of the component (B) play a critical roll in the degree of the sound absorption of the resin composition of the present invention, and significantly impact on the processability and surface appearance of a final molded article. When the mixing ratio is below 1:9, the sound absorption properties cannot be sufficiently anticipated and the processability is bad. When the mixing ratio exceeds 9:1, the sound absorption properties are improved but the surface appearance of a final molded article is bad and the moldability is poor. If barium sulfate is used alone, instead of the mixture of talc and barium sulfate, the sound absorption properties are slightly improved, compared to when talc is used alone. However, the use of barium sulfate only causes difficult molding due to high hygroscopicity of barium sulfate. If the talc is used alone, instead of the mixture of talc and barium sulfate, the heat resistance is excellent, compared to when barium sulfate is used alone. However, the use of talc only causes difficult molding due to bad surface appearance. The combination of talc and barium sulfate as the component (B) can solve the problems, e.g., poor sound absorption properties, heat resistance and impact resistance, caused by the use of either barium sulfate or talc alone.

The content of the component (B) in the resin composition of the present invention is adjusted within the range of 15~50% by weight. When the content of the component (B) is less than 15% by weight, improved sound absorption properties cannot be anticipated. On the other hand, when the content of the component (B) is
above 50% by weight, molding into a final article is difficult and the weight of the resin composition is unfavorably increased.

The content of the component (C) in the resin composition of the present invention is adjusted to 10% by weight or less, and preferably within the range of 0.01~10% by weight, in order to reduce the weight of the resin composition, and at the same time, to improve the strength, hardness and sound absorption properties while maintaining the heat resistance and impact resistance. If the component (C) is excluded from the resin composition of the present invention, the heat resistance and impact resistance cannot be maintained, the weight of the resin composition cannot be reduced, and the strength, hardness and sound absorption properties cannot be improved. On the other hand, when the component (C) is present in an amount exceeding 10% by weight, the reduction effects in the weight of the component (B) are none or few, the price is high and the impact resistance is deteriorated.

If necessary, the resin composition of the present invention further comprises (D) a compatibilizer. Examples of the component (D) usable in the present invention include carboxyl group-terminated polyethylenes (COOH-PE), carboxyl group-terminated polypropylenes (COOH-PP), maleic anhydride-terminated polypropylenes (MAH-PP), poly(styrene-acrylic acid) (P(St-AA)), polystyrene-polyimide block copolymers (PS-PI), polystyrene-polyethylene block copolymers (PS-PE), styrene-ethylene-butadiene-styrene block copolymers (SEBS), polystyrene-polymethylmethacrylate block copolymers (PS-PMMA), polystyrene-polybutyldipate block copolymers (PS-PBA), polystyrene-polycarprolactone block copolymers (PS-PCL), polypropylene-polyamide graft copolymers (PP-g-PA), polybutyleneterephthalate-polyamide graft copolymers (PBT-g-PA), polypropylene-maleic anhydride graft copolymers (PP-g-MA), syndiotactic polystyrene-maleic anhydride graft copolymers (sPS-g-MA) and styrene-ethylene-butadiene-styrene-maleic anhydride graft copolymers (SEBS-g-MA), and preferably include polypropylene-maleic anhydride graft copolymers (PP-g-MA), syndiotactic polystyrene-maleic anhydride graft copolymers (sPS-g-MA) and styrene-ethylene-butadiene-styrene-maleic anhydride graft copolymers (SEBS-g-MA). Polypropylene-maleic anhydride graft copolymers (PP-g-MA) are preferred.

Polymers generally used as compatibilizers are mostly present in the form of block or graft copolymers, and are largely divided into reactive and non-reactive compatibilizers. The reactive compatibilizers are copolymers in which functional groups are introduced. Even a small amount of the reactive compatibilizers can obtain desired physical properties, but may cause deterioration in physical properties due to
side reactions. In contrast to the reactive compatibilizers, since the non-reactive
compatibilizers facilitates the kneading molding of the resin composition and cause
little or no deterioration in physical properties due to side reactions, they are preferably
used in the present invention.Compatibilizers are prepared in the same manner as
conventional synthetic methods of block or graft copolymers. The copolymers PP-g-
MA, sPS-g-MA and SEBS-g-MA have a grafting ratio of 0.2~2.0. The content of the
(D) compatibilizer in the resin composition of the present invention is controlled to not
more than 5% by weight, and preferably within the range of 0.01~5% by weight.

In addition to these components (A)~(D), the resin composition of the present
invention may further comprise at least one additive selected from the group consisting
of primary antioxidants, secondary antioxidants, lubricants and slip agents in an amount
of 0.1~5.0 parts by weight, based on 100 parts by weight of total resin composition.

Where necessary, the resin composition of the present invention further
comprises a plasticizer, a heat stabilizer, a photostabilizer or the like. Further, an
organic or inorganic pigment, or a dye may be added to the resin composition of the
present invention, so far as it does not detract from the object of the present invention.

The polypropylene resin composition of the present invention is prepared by
melt-mixing the above-mentioned components in accordance with conventional
processes, e.g., using a twin-screw extruder. After the polypropylene resin
composition is completely dried, it can be molded into wastewater discharge pipes
(linear pipes and joint pipes) by extrusion and injection molding processes using a pipe
molding machine.

**Best Mode for Carrying Out the Invention**

The present invention will now be described in more detail with reference to
the following preferred examples and comparative examples. However, these
examples are given for the purpose of illustration and are not to be construed as
limiting the scope of the invention.

**Evaluation of physical properties**

Various physical properties and sound absorption properties of pipes
manufactured from the resin composition of the present invention were evaluated in
accordance with the following test methods:

1) Melt index: The flowability of the resin was measured under a load of
2.16kg at 230°C in accordance with the ASTM D1238 standard test method, and
expressed in g/min.

2) Specific gravity: Measurement was carried out using buoyancy in a liquid in accordance with the ASTM D1505 standard test method.

3) HDT: Specimens (length: 127mm, width: 12.7mm and thickness: 6.4mm) molded using an injection molding machine were used. Measurement was carried out by testing the specimens under loads of 4.6 and 18.5 kgf/cm² in accordance with the ASTM D648 standard test method.

4) Hardness: Measurement was carried out 30 seconds after a load of 10N was vertically applied on an Asca type A durometer in accordance with the ASTM D2240 standard test method.

5) Tensile strength and elongation: A specimen having a thickness of 2±0.5mm was used. Measurement was carried out at a tensile speed of 50 mm/min. by a tensile tester in accordance with the ASTM D412 standard test method.

6) Vicat softening point: Measurement was carried out in accordance with the JIS-K7206 standard test method. The measured Vicat softening point was used as an index of heat resistance. That is, the higher the Vicat softening point, the better the heat resistance.

7) Spiral flow: The flowability was measured upon injection molding at 230°C using an injection-molding machine in accordance with the test method developed by the present applicant, and expressed in centimeters.

8) Flexural strength: Measurement was carried out by bending a pipe at a bending speed of 5 mm/min., until load was not any longer increased (i.e. maximum load), in accordance with the ASTM D790 standard test method.

9) Flexural modulus of elasticity: Measurement was carried out by plotting a load curve while bending a pipe at a speed of 5 mm/min., in accordance with the ASTM D790 standard test method. The flexural modulus of elasticity was obtained from the slope of initial linear section.

10) Izod impact strength: Measurement was carried out using a 3.2mm-thick injection-molded specimen in accordance with the ASTM D256 standard test method.

11) Sound absorption properties: Tan δ (23°C) values was measured according to varying frequencies (rad/s), and expressed in dB. The higher the Tan δ value (i.e. the lower the dB value), the better the sound absorption properties. A pipe having a thickness of 3.1mm and a diameter of 42Φmm was used for measurement.

Examples 1~4 and Comparative Example 1 and 2

A polypropylene resin, sound-absorbing components and other additives in
acCORDANCE WITH THE COMPOSITIONS INDICATED IN TABLE 1 WERE FED TO A CO-ROTATING TWIN-
SCREW EXTRUDER, MELT-MIXED AND EXTRUDED TO PREPARE RESIN COMPOSITIONS IN PELLET FORM.
The resins were dried under vacuum at 80°C.

Pipes were manufactured from the resin compositions using a 420mm-thick pipe molding machine. Various physical properties including heat resistance and impact resistance, and sound absorption properties of the pipes were evaluated in accordance with the above-mentioned test methods. The results are shown in Table 2 below.

### Table 1

<table>
<thead>
<tr>
<th>Components</th>
<th>Kinds</th>
<th>Exa. 1</th>
<th>Exa. 2</th>
<th>Exa. 3</th>
<th>Exa. 4</th>
<th>Comp. Exa. 1</th>
<th>Comp. Exa. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polypropylene resin (A) (wt%)</td>
<td>PP$^{1}$</td>
<td>60</td>
<td>60</td>
<td>57.5</td>
<td>55</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>Fillers (B) (wt%)</td>
<td>Talc$^{2}$</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>Clay M/B (wt%)</td>
<td>Barium sulfate$^{3}$</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>Compatibilizer (D) (wt%)</td>
<td>CNA$^{4}$</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additives (E) (parts by weight: based on 100 parts by weight of the total resin composition)</td>
<td>CNA25$^{5}$</td>
<td>2.5</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium stearate$^{6}$</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Primary antioxidant$^{6}$</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Secondary antioxidant$^{9}$</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Wax$^{10}$</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
</tbody>
</table>

[Note]
1) PP: An impact copolymer having an Izod impact strength (room temperature) of 50 kg-cm/cm or more (BB110, manufactured by Samsung General Chemicals Co., Korea), or a random copolymer having an Izod impact strength (room temperature) of 2–10 kg-cm/cm (RP100, RB200 or RS401, manufactured by Samsung General Chemicals Co., Korea), or an impact copolymer having an Izod impact strength (room temperature) of 11–20 kg-cm/cm (BJ100 or BJ300, manufactured by Samsung General Chemicals Co., Korea).
2) Talc: KCM6300 (manufactured by KOCH)
3) Barium sulfate: BaSO$_4$ (manufactured by Solvay)
4) CNA: Nano-Clay M/B (manufactured by Samsung General Chemicals Co., Korea) containing 50% of Cloisite-Na+ (manufactured by Southern Clay Products Inc.)
5) CNA25: Nano-Clay M/B (manufactured by Samsung General Chemicals Co., Korea) containing 25% of Cloisite-Na+ (manufactured by Southern Clay Products
6) Modified PP: CP4673 (manufactured by Samsung General Chemicals Co., Korea)
7) Calcium stearate: Ca-St (manufactured by Songwon Industrial Co., Ltd., Korea)
8) Primary antioxidant: I-1010 and I-168 (manufactured by CIBA GEIGY, Japan)
9) Secondary antioxidant: DSTDP (manufactured by Dongbo Chemical, Korea)
10) Wax: L-C102N (manufactured by Lionchem)

Table 2

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Exa. 1</th>
<th>Exa. 2</th>
<th>Exa. 3</th>
<th>Exa. 4</th>
<th>Comp. Exa. 1</th>
<th>Comp. Exa. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI (2.16kgf)</td>
<td>1.0</td>
<td>0.6</td>
<td>0.7</td>
<td>0.7</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>1.2111</td>
<td>1.2078</td>
<td>1.2113</td>
<td>1.2090</td>
<td>1.4250</td>
<td>1.776</td>
</tr>
<tr>
<td>Tensile strength (yield)</td>
<td>298</td>
<td>321</td>
<td>325</td>
<td>341</td>
<td>275</td>
<td>215</td>
</tr>
<tr>
<td>Elongation</td>
<td>60</td>
<td>52</td>
<td>44</td>
<td>26</td>
<td>88</td>
<td>36</td>
</tr>
<tr>
<td>Surface hardness</td>
<td>87</td>
<td>89</td>
<td>92</td>
<td>92</td>
<td>85</td>
<td>76</td>
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<tr>
<td>Izod (Notch)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>23°C</td>
<td>20</td>
<td>12</td>
<td>11</td>
<td>10</td>
<td>36</td>
<td>-</td>
</tr>
<tr>
<td>0°C</td>
<td>8.5</td>
<td>6.9</td>
<td>5.7</td>
<td>6.4</td>
<td>7.2</td>
<td>7.2</td>
</tr>
<tr>
<td>-20°C</td>
<td>5.5</td>
<td>4.4</td>
<td>3.9</td>
<td>4.2</td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td>Dupont (21 sheet), 23°C, 0°C</td>
<td>196</td>
<td>165</td>
<td>151</td>
<td>135</td>
<td>334</td>
<td>160</td>
</tr>
<tr>
<td>0°C</td>
<td>193</td>
<td>188</td>
<td>184</td>
<td>185</td>
<td>200</td>
<td>110</td>
</tr>
<tr>
<td>-20°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDT (4.6kgf)</td>
<td>132</td>
<td>133</td>
<td>135</td>
<td>125</td>
<td>131</td>
<td>104</td>
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<tr>
<td>(18.5kgf)</td>
<td>75</td>
<td>77</td>
<td>78</td>
<td>78</td>
<td>79</td>
<td>65</td>
</tr>
<tr>
<td>Vicat (1kgf)</td>
<td>155</td>
<td>155</td>
<td>155</td>
<td>156</td>
<td>155</td>
<td>-</td>
</tr>
<tr>
<td>Flexural strength</td>
<td>498</td>
<td>518</td>
<td>527</td>
<td>550</td>
<td>472</td>
<td>390</td>
</tr>
<tr>
<td>Flexural modulus of elasticity</td>
<td>30,700</td>
<td>29,300</td>
<td>30,100</td>
<td>30,500</td>
<td>36,900</td>
<td>31,700</td>
</tr>
<tr>
<td>Sound absorption properties</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tan δ (0.1 rad/s)</td>
<td>0.165</td>
<td>0.166</td>
<td>0.176</td>
<td>0.189</td>
<td>0.166</td>
<td>0.127</td>
</tr>
<tr>
<td>(1.0 rad/s)</td>
<td>0.139</td>
<td>0.141</td>
<td>0.150</td>
<td>0.160</td>
<td>0.141</td>
<td>0.095</td>
</tr>
<tr>
<td>(10.0 rad/s)</td>
<td>0.114</td>
<td>0.119</td>
<td>0.128</td>
<td>0.137</td>
<td>0.119</td>
<td>0.075</td>
</tr>
<tr>
<td>(100.0 rad/s)</td>
<td>0.106</td>
<td>0.112</td>
<td>0.125</td>
<td>0.134</td>
<td>0.112</td>
<td>0.073</td>
</tr>
<tr>
<td>dB</td>
<td>36</td>
<td>36</td>
<td>35</td>
<td>34</td>
<td>32</td>
<td>46</td>
</tr>
</tbody>
</table>

As can be seen from Table 2, the resin compositions comprising impact copolymers having excellent impact resistance and mechanical properties as polypropylene resins, and a mixture of talc and barium sulfate as sound-absorbing components, exhibited good processability while maintaining superior heat resistance, impact resistance and sound absorption properties. In addition, the resin compositions were advantageous in terms of being light-weight.

Although the preferred embodiments of the present invention have been
disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.
Claims

1. A polypropylene resin composition, comprising:
   (A) 55~70% by weight of a polypropylene resin;
   (B) 15~50% by weight of a mixture of talc and barium sulfate, the mixing
   weight ratio of talc to barium sulfate being in the range of 1:9~9:1; and
   (C) 0.01~15% by weight of nano-clay.

2. The polypropylene resin composition according to claim 1, further
   comprising (D) 0.01~5% by weight of a compatibilizer.

3. The polypropylene resin composition according to claim 1 or 2, wherein the
   polypropylene resin is a crystalline homopolypropylene having an isotactic pentad
   fraction of 0.80~0.99.

4. The polypropylene resin composition according to claim 1 or 2, wherein the
   polypropylene resin is a random copolymer having an Izod impact strength at room
   temperature of 2~10 kg/cm/cm as a propylene-ethylene random copolymer.

5. The polypropylene resin composition according to claim 1 or 2, wherein the
   polypropylene resin is an impact copolymers having an Izod impact strength at room
   temperature of 11 kg/cm/cm or more as a propylene-ethylene block copolymer.

6. The polypropylene resin composition according to claim 1 or 2, wherein the
   polypropylene resin has a melt index (ASTM D1238: 230°C, load of 2.16kg) of 0.1~60
   g/10min.

7. The polypropylene resin composition according to claim 1 or 2, wherein the
   compatibilizer is a polypropylene-maleic anhydride graft copolymers (PP-g-MA) and
   has a grafting ratio of 0.2~2.0.

8. The polypropylene resin composition according to claim 1 or 2, wherein the
   resin composition further comprises at least one additive selected from the group
   consisting of primary antioxidants, secondary antioxidants, lubricants and slip agents in
   an amount of 0.1~5.0 parts by weight, based on 100 parts by weight of total resin
   composition.
### A. CLASSIFICATION OF SUBJECT MATTER

**IPC7** C08L 23/12, C08K 3/30, C08K 7/00, C08L 53/00, C08K 3/00

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)

**IPC7** C08L 23/12, C08K 3/30, C08K 7/00, C08L 53/00, C08K 3/00

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

Korean Patents and applications for inventions since 1975

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

KIPASS, JAPIO, USPTO, FPDO

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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Further documents are listed in the continuation of Box C. See patent family annex.

| * | Special categories of cited documents: |
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| **O** | document referring to an oral disclosure, use, exhibition or other means |
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*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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**Y** document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search: 26 APRIL 2004 (26.04.2004)

Date of mailing of the international search report: 27 APRIL 2004 (27.04.2004)

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LEE, Ha Yeon

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