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(54) **CARPET WITH A HIGH LIGHT REFLECTANCE VALUE AND METHOD OF PRODUCING SUCH CARPET**

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(57) **ABSTRACT**

Besides a method for manufacturing a carpet, the invention further relates to a carpet with a LRV higher than 30. In particular such carpet comprises yarns are made of PP/PA/PET/PTT/PBT, which are either white based or solution dyed based, and tufted on a white or very light woven or web substrate, such as PET and/or PP, pre-coated with a polyolefin such as HYPOD or SBR which is whitened with a filler, such as $MgCO_3$, TiO_2, ATH, and/or $CaCO_3$, and which may comprise, in particular in the case of loose laid tiles, a secondary heavy coating consisting of a very light coloured secondary heavy coating such as a specific polyolefin, PVC, PVB, EVA or a (synthetic) bitumen, loaded with a filler pre-selected on lightness and purity as CaCO3 and/or ATH and/or specific salts, e.g. NaCl or TiO_2.

CARPET WITH A HIGH LIGHT REFLECTANCE VALUE AND METHOD OF PRODUCING SUCH CARPET

[0001] The present invention relates a carpet with a high light reflectance value, and a method for producing such carpet.

[0002] It is known that people and their behaviour and/or well-being depends on the amount of light in their environment. Architects, designers and the construction industry use this knowledge to either improve visual ergonomics in designing buildings/interiors or support in creating lighting plans.

[0003] The amount of light in a room evidently depends on the illumination, either by sun or artificial light, but also by the way the light is absorbed or reflected by the room and the objects placed therein.

[0004] The 2008 report BS8493 from the British Standards Institution, provides a method for quantifying the amount of reflection of light by a certain object, with its so called light reflectance value (LRV), which is defined as the total quantity of visible light reflected by a surface (e.g. floorings, ceilings, walls and furniture), at all wavelengths and directions when illuminated by a light source, which may be sunlight or artificial light.

[0005] The LRV scale runs from 0, which is a perfectly absorbing surface (assumed to be totally black), up to 100, which is a fully reflective surface (considered to be perfectly white). Because of practical influences in any application, black is always greater than 0 and white never equals 100. Additional to colour, the structure and luster (gloss) of the product or surface can influence the LRV. LRV measurements are best performed using a spectrophotometer. This equipment accurately and directly measures the LRV of flat and curved items, matt and lustered (including carpet).

[0006] Another method is developed by the Commission Internationale de l'Eclairage (CIELAB) and uses three coordinates to locate a colour in a colour space and is used to describe colours that are visible to the human eye. This colour system quotes values for L*, a* and b*, wherein these three parameters of the colour model represent the lightness of the colour ranging from white to black, L*, its position between red and green, a*, and its position between yellow and blue, b*.

[0007] The L* value (colour depth) can be used to calculate the LRV of a surface (also referred to as the 'ρ-value' (rho)), as a close approximation of the directly measured LRV according BS8493, by the following formula:

$$LRV=\mathrm{rho}(\rho)=100\times((L^*+16)/116)^3$$

[0008] In order to assist people, especially those with a visual impairment, to find their way around, it is a requirement that there is a visual contrast between the floor and the walls and between different levels of the floor or on stairs. The greater the difference in LRV between two surfaces, the more likely the difference is identified. According to the British Standards Institution, whilst there is a considerable confidence in recommending a difference of LRV of 30 points or more (the good zone), there is also much anecdotal evidence to suggest that a difference of around 20 points may still be acceptable.

[0009] Furthermore, products with higher LRV values help to reflect incoming light, either daylight or artificial, to reinforce its effect. This offers the possibility to reduce the need of artificial light in a room or building and therefore saves on energy (up to 30%) use and costs (related to lighting). Due to its large surface, carpet can play a significant role in contributing to a higher light reflectance value.

[0010] There are two important factors that influence the LRV of a carpet, being the yarn from which the loop piles are made, and the fabric or web from which the tuft substrate is made, including the secondary backing. For broadloom carpet, that is, carpet which is laid in one piece in room, the influence of the backing material on the light reflectance value is relatively small.

[0011] In the case the carpet is cut and laid as multiple separate tiles, the tangent interfaces of the separate tiles may become visible, and therefore impose more stringent requirement. Furthermore, for practical reasons, there is a minimal weight for loose laid carpet tiles, which is a mass that is higher than 3500 g/m^2.

[0012] So, although broadloom carpet with higher LRVs may be offered, loose laid carpet tiles with a high LRV, i.e. a value above 30, and preferably more than 35, is seen as impossible for especially loop pile and fibre bonded substrates with the current build up of the product, since visibility of carpet tile edges is common practice when installed monolithically, ashlar or brickwise.

[0013] Typically, the method for manufacturing a carpet tile comprises the steps of tufting onto a tuft substrate, either loop pile/cut pile or combination of those or the technique of fibre bonding, subsequently applying a primary coating (e.g. SBR/polyacrylates/polyolefin/polyesters) to the top-cloth substrate in order to fix the pile yarn, and then applying a secondary coating (polyolefin/bitumen/EVA/PVC) to the primary coating. For carpet tiles it may be finished with a glass scrim and/or protection fleece of any colour.

[0014] The reason for visibility of the carpet tile edges with high LRV colours needs to be found in the area of the used colour of the different layers in the product build-up. By die cutting (or alternatives as ultrasonic/knife/water cutting/laser) carpet tiles (e.g. from roll goods/platines) some piles at the cutting edges are damaged or half lost, since only part of the tufts are "locked in" the primary backing. When then, installing these carpet tiles, (half) tuft holes of imperfections are present. Depending on the tuft machine gauge this may range between 2 mm (5⁄64") to 2.5 mm (1⁄10") to 3.2 mm (1⁄8") to 4.0 mm (5⁄32"). When the colour contrast then, between pile yarn and backing is too high, or by light shadow effect, this will be visible as imperfect carpet tile edge covering. The darker backing colour becomes visible in between the tiles, at the edges of the carpet tiles. Next to that, also some layers as e.g. bitumen compound can contaminate the die cutting equipment or cutting knife, basically accentuating the edges of the next die cut by contaminating e.g. pile yarn and/or primary backing.

[0015] Further development has shown that yet another way of influencing the amount of light in a room may be to project light through the carpet into the room. The carpet may for instance be laid on a transparent (for instance glass) floor, or one or more light sources may be applied under the carpet, to shine light through at least part of the carpet. The light may be a constant and uniform light, but (time dependent) patterns and colours are thinkable too. Although for this purpose, similar requirements may be set to the carpet as for obtaining a high reflectance value.

[0016] It is a goal of the present invention to take away the above disadvantages of the prior art, and to propose a carpet that contributes to visual ergonomics and lighting plans.

[0017] The invention thereto proposes a method for manufacturing a carpet, comprising tufting yarns onto a substrate and then pre-coating the substrate, wherein the combination of the yarns and the substrate has a light reflectance value above 30, and more in particular above 35. Herein, the substrate may be manufactured by needling fibres to become a substrate, and the yarns may be tufted onto the substrate into loop pile.

[0018] The yarns may for example be made of one ore more materials from the group of PP, PA (e.g. PA6, PA66, PA6.10, PA10, PA11, PA12), PET, PTT or PBT, and may be based on white (overdyable) yarns or solution dyed yarns.

[0019] Staining may be seen as a disadvantage, especially for the colours with high LRV values. Therfor, the polymer types of the polyester family is favourable. More specific the PTT (Poly Trimethylene Terephtalate) and/or PBT (Poly Buthylene Terephtalate). PBT has, compared to PA, a very low water take-up of ca. 0.4% compared to a range between 2-8% for polyamides, which reduces dye-ability as well as stain-ability on one hand but also good carpet tile dimensional stability on the other hand. Next to this, PTT/PBT have also intrinsic, excellent chemical resistance, which is resulting in very good stain resistant carpet fibres. Infinite recycling opportunities (mono ingredient carpet tile) are possible with polyesters, including PBT yarns, hotmelt PET/PTT/PBT pre-coating as well as PET/PTT/PBT secondary backing.

[0020] The substrate or backing may be a woven or non-woven backing. Preferably PET/PP or bi-component PET/PP fibres can be used for this primary backing, consisting of a PET core, manteled with a PP skin, for improved dimensional stability, but moreover for the soil and stain resistance, avoiding carpet tile edges to soil. In order to fix the yarns to the substrate, the substrate may be pre-coated with a polyolefin such as HYPOD or SBR, whitened with a filler, such as $MgCO_3$, TiO_2, ATH and/or $CaCO_3$ or others. Such pre-coat may be applied either via dispersion or hotmelt, or any other known method, and the $MgCO_3$, TiO_2, ATH and/or $CaCO_3$ may have a chemical purity higher than 90%, in particular more than 95%, and preferably even more than 99%.

[0021] In practice, a polyolefin or SBR with ATH had proven to be very effective for obtaining a high reflectance value. However, when light has to enter a room through the carpet, transparency becomes a more important issue, and $CaCO_3$ and $MgCO_3$ may be preferred. ATH may be added for e.g. fire retardancy.

[0022] A pre-coating recipe that appeared to be very suitable for a carpet, in particular a light transparent carpet, comprises a polyolefin and/or a SBR mixture with a filler consisting of a mixture of 30% $CaCO_3$, 25% $MgCO_3$/50% ATH. This mixture may be optimised in shifting percentages of each ingredient (resp. in the range of $CaCO_3$ (0-70), $MgCO_3$ (0-70), ATH (30-100), and even additional TiO_2 (0-5). The above mixture further enables to meet the (weight and fire retardancy) requirements set to carpet tiles.

[0023] In particular for loose laid carpet, or carpet tiles, the method according to the invention may comprise applying a very light coloured secondary heavy coating, which can for example be a specific polyolefin, PVC, PVB, EVA or a synthetic bitumen.

[0024] For this, it was proven that polyolefin polymers based on either PE and/or PP did not fulfill the carpet tile performance based on dimensional stability and lay flat performance under all practical in-situ circumstances as a temperature range between 5 and 40 degrees Celsius and a percentage of relative humidity between 20% and 80%.

[0025] Herein, the viscosity behaviour (process) on one hand as well as temperature resistance, flexibility, mechanical strength and dimensional stability of the product are key polymer blend characteristics.

[0026] Suitable recipes for the heavy coating layer are a specific polymer blend based on polyolefin copolymers, tackifiers and wax/oil which may be filled with $CaCO_3$ and/or ATH and/or other salts, e.g. NaCl or $MgCO_3$ may be used. The polyolefin copolymers, in particular block copolymers, are suitable, due to their spacious molecular geometry, which has proven to have very good light transmitting properties. The filler preferably has a high purity (>90%), high whiteness (>90%), and particle size ranging from ca. 1 μm-300 μm. Such filler with the described purity is commercially available as Imercarb, Martinal, Reflamal, Omyacarb, Merck ATH, Jozo salt, Merck $CaCO_3$ and Alpha Calcit. A heavy coating recipe that appeared to be very suitable for a carpet (that can be recycled as well) comprises a mixture of about 50% tackifier, about 30% olefin block copolymer and about 20% oil-wax. This mixture may be optimised in shifting percentages of each ingredient with max +/−20%. (e.g. 35% tackifier, 35% olefin block copolymer and 30% of oil/wax) The filler level may vary between 20 to 80%, and more in particular 60-75%.

[0027] Among the group of suitable block copolymers, TPE's (thermoplastic elastomers) where a phase separation within the polymer blend is occurring of polymer blocks A and polymer blocks B have shown to be very suitable. These separated interlinked domains determine the new polymer block copolymer properties. Known, classic block copolymer examples are SBC's (Styrene Butadiene block copolymer) or, TPU's (Thermoplastic PolyUrethene), and TPO's (Thermoplastic polyolefins), Specifically, TPO's based on block copolymers based on ethene with e.g. blocks butane and/or hexane and/or octane and/or maleic anhydride proved to be very suitable. For example Dow ENGAGE XLT, AFFINITY™, AMPLIFY™, INFUSE™.

[0028] Tackifier, either based on rosin esters or based on hydrogenated hydrocarbon resins, (a selection of e.g. Eastman Staybelite, Foralyn, Foral, Pentalyn, Regalite, Regalrez, Eastotac, Piccotac types) may be selected based on adhesion properties as well as VOC emission profiles. Oil (white mineral) and Waxes (mixture of saturated hydrocarbons) are added for processability (viscosity), softer material at room temp and, after application of heavy coating faster solidification during processing.

[0029] The following colours with their Natural Color System values (NCS) and LRV have proven to be very useful for manufacturing carpet according to the present invention.

Desso SAP:	LRV	NCS:
1107	43.65	S1502-B50G
1908	35.54	S2020-Y20R
2917	43.97	S2010-Y10R
9037	35.32	S3005-B20G
1610	51.09	S1010-Y20R
1321	42.22	S2005-Y30R
1660	34.81	S2010-Y20R

[0030] Besides the methods for manufacturing carpets as described above and the carpets directly obtained from these methods, the present invention further relates to carpet com-

prising loop pile yarns tufted onto a substrate, the substrate having a precoat with a polyolefin or SBR with a filler comprising one or more components from the group of $MgCO_3$, $CaCO_3$, ATH and/or TiO_2 and a heavy coating layer comprising a polymer blend based on a synthetic bitumen or polyolefin co-polymer. These carpets may in particular be suitable to transmit lights when they are arranged on a light source.

[0031] In such carpet the filler may comprise for instance $MgCO_3$, $CaCO_3$, ATH and/or TiO_2 with a chemical purity higher than 90%, and the heavy coating layer further comprises tackifiers and wax/oil, filled with one or more components from the group of $CaCO_3$, ATH, NaCl, $MgCO_3$.

1.-11. (canceled)

12. A method for manufacturing a carpet tile wherein the combination of the yarns and the substrate has a light reflectance above 30 according to the 2008 report BS8493 from the British Standards Institution, comprising:

tufting white based or solution dyed based yarns onto a light coloured or white PET and/or PP substrate into loop pile;

precoating the substrate with a polyolefin or SBR with filler comprising $MgCO_3$, $CaCO_3$, ATH and/or TiO_2 with a chemical purity higher than 90%; and

applying a heavy coating layer comprising a polymer blend based on one of a synthetic bitumen filled with one or more components from the group of $CaCO_3$, ATH, NaCl, $MgCO_3$ and a polyolefin co-polymer, tackifiers and wax/oil, filled with one or more components from the group of $CaCO_3$, ATH, NaCl, $MgCO_3$.

13. The method according to claim **12**, wherein the copolymer is a block-copolymer, in particular from the TPO's based on block co-polymers of ethene with e.g. blocks butane and/or hexane and/or octane and/or maleic anhydride.

14. The method according to claim **12**, comprising mixing about 50% tackifier, about 30% olefin (block) co-polymer and about 20% Oil-wax.

15. The method according to claim **12**, comprising applying between 20 to 80%, and more in particular 60-75% filler.

16. The method according to claim **12** wherein the yarns are made of PP/PA/PET/PTT/PBT.

17. The method according to claim **12**, comprising adding $TiO_2/MgCO_3/CaCO_3$/ATH to the pre-coat and/or heavy coating.

18. The method according to claim **12**, wherein the filler has a particle size ranging from ca. 1 μm-300 μm.

19. A carpet having a light reflectance above 30 according to the 2008 report BS8493 from the British Standards Institution, comprising:

loop pile yarns tufted onto a substrate;

the substrate having a precoat with a polyolefin or SBR with a filler comprising one or more components from the group of $MgCO_3$, $CaCO_3$, ATH and/or TiO_2; and

a heavy coating layer comprising a polymer blend based on one of a synthetic bitumen filled with one or more components from the group of $CaCO_3$, ATH, NaCl, $MgCO_3$ and a polyolefin co-polymer, tackifiers and wax/oil filled with one or more components from the group of $CaCO_3$, ATH, NaCl, $MgCO_3$.

20. The carpet according to claim **19**, wherein the filler comprises $MgCO_3$, $CaCO_3$, ATH and/or TiO_2 with a chemical purity higher than 90%.

21. The carpet according to claim **19**, wherein the heavy coating layer further comprises tackifiers and wax/oil, filled with one or more components from the group of $CaCO_3$, ATH, NaCl, $MgCO_3$.

22. The carpet according to claim **19**, cut to a tile, for instance a 30×30 cm, a 40×40 cm, a 50×50 cm or a 60×60 cm tile.

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