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(54) **A method of coating a substrate, and a surface covering**

(57) A method of coating a substrate comprises the steps of: supplying a substrate, applying at least a base layer of a first curable substance having a viscosity of 1000-10000 cP at 25 °C on the substrate, applying at least a cover layer of a second curable substance having

a viscosity of 100-2000 cP at 25 °C on the base layer, wherein the cover layer is thicker than the base layer, wherein both the first and second substances comprise polyurethane acrylate and reactive diluent.

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## Description

**[0001]** The present invention is related to a method of coating a substrate.

**[0002]** In the field of manufacturing surface coverings, in particular floor panels, several methods of coating a substrate are known. In many applications a substrate needs more than one layer to be coated since different layers may have different functions. For example, a first layer on a substrate may function as a primer and a next layer may function as a wear-resistant layer.

**[0003]** It is an object of the invention to provide a more efficient way of manufacturing.

**[0004]** This is achieved with the method of coating a substrate according to claim 1.

**[0005]** The advantage of the invention is that the high-viscosity substance of the base layer has great filling characteristics when coating a substrate which has a relatively rough surface, whereas a high-speed coating process can be achieved with the low-viscosity substance of the cover layer. This is useful because of the relatively thick cover layer in comparison to the base layer.

**[0006]** Polyurethane is a polymer composed of a chain of organic units joined by carbamate links. Polyurethane polymers are formed by reacting isocyanate (aromatic or aliphatic) with a polyol. Both the isocyanates and polyols used to make polyurethanes contain on average two or more functional groups per molecule. By means of esterification of alcoholic functions of intermediate products, for example by using acrylic acid, polyurethane acrylate polymers can be formed. Non-limiting examples of types of polyurethane acrylate are aliphatic polyester urethane acrylate, aliphatic urethane acrylate, aromatic urethane acrylate, or urethane acrylate.

**[0007]** It is noted that polyurethane acrylate could be replaced by methacrylate. This may be formed by using methacrylic acid.

**[0008]** Polyurethane acrylate covers a family of substances. The types of polyurethane acrylate in the base layer and the cover layer are at least members of the same family of polyurethane acrylate, but may be different members or identical members. If identical members are applied a single source of polyurethane acrylate can be used in a manufacturing process for both layers.

**[0009]** In practice the first curable substance may be diluted less than the second curable substance, but still the same basic material supply of polyurethane acrylate can be applied.

**[0010]** In an embodiment of the method the viscosity of the first substance is higher than of the second substance. For example, the viscosity of the first substance is 1000-10000 cP at 25 °C and of the second substance is 100-1000 cP at 25 °C, or 2000-10000 cP and 100-2000 cP, respectively.

**[0011]** The first and second substances may also comprise non-reactive diluents such as water, ethylacetate, acetone, MEK (methyl ethyl ketone), alcohols (ethanol,

methanol, isopropanol, n-propanol), or the like in order to reduce the viscosity of the substance. These non-reactive diluents will be evaporated upon curing the mixture of polyurethane acrylate or methacrylate and reactive diluent.

**[0012]** According to claims 4-7 a variation of dilution ratios of polyurethane acrylate is possible. The viscosities of the first and second substances depend on the dilution ratios and the temperature. In general, viscosity decreases by raising temperature, but in particular for the cover layer a higher dilution may be required to apply the substance at a reasonable relatively low temperature.

**[0013]** The reactive diluent may be at least of isoamyl acrylate, stearyl acrylate, lauryl acrylate, octyl acrylate, decyl acrylate, isoamylstyl acrylate, isostearyl acrylate, 2-ethylhexyl-diglycol acrylate, 2-hydroxybutyl acrylate, 2-acryloyloxyethylhexahydrophthalic acid, butoxyethyl acrylate, ethoxydiethylene glycol acrylate, methoxydiethylene glycol acrylate, methoxypolyethylene glycol acrylate, methoxypropylene glycol acrylate, phenoxyethyl acrylate, tetrahydrofurfuryl acrylate, isobornyl acrylate, 2-hydroxyethyl acrylate, 2-hydroxypropyl acrylate, 2-hydroxy-3-phenoxypropyl acrylate, vinyl ether acrylate, 2-acryloyloxyethylsuccinic acid, 2-acryloyloxyethylphthalic acid, 2-acryloyloxyethyl-2-hydroxyethylphthalic acid, lactone modified flexible acrylate, and t-butylcyclohexyl acrylate, triethylene glycol diacrylate, tetraethylene glycol diacrylate, polyethylene glycol diacrylate, dipropylene glycol diacrylate, tripropylene glycol diacrylate, polypropylene glycol diacrylate, 1,4-butanediol diacrylate, 1,6-hexanediol diacrylate, 1,9-nonanediol diacrylate, neopentyl glycol diacrylate, dimethylol-tricyclodecane diacrylate, bisphenol A EO (ethylene oxide) adduct diacrylate, bisphenol A PO (propylene oxide) adduct diacrylate, hydroxypivalate neopentyl glycol diacrylate, propoxylated neopentyl glycol diacrylate, alkoxyated dimethyloltricyclodecane diacrylate and polytetramethylene glycol diacrylate, trimethylolpropane triacrylate, EO modified trimethylolpropane triacrylate, tri (propylene glycol) triacrylate, caprolactone modified trimethylolpropane triacrylate, pentaerythritol triacrylate, pentaerythritol tetraacrylate, pentaerythritolethoxy tetraacrylate, dipentaerythritol hexaacrylate, ditrimethylolpropane tetraacrylate, glycerinpropoxy triacrylate, and caprolactam modified dipentaerythritol hexaacrylate, or an N-vinylamide such as, N-vinylcaprolactam or N-vinylformamide ; or acrylamide or a substituted acrylamide, such as acryloylmorpholine.

**[0014]** Other suitable monofunctional acrylates include caprolactone acrylate, cyclic trimethylolpropane formal acrylate, ethoxylated nonyl phenol acrylate, isodecyl acrylate, isooctyl acrylate, octyldecyl acrylate, alkoxyated phenol acrylate, tridecyl acrylate and alkoxyated cyclohexanone dimethanol diacrylate.

**[0015]** Other suitable difunctional acrylates include alkoxyated cyclohexanone dimethanol diacrylate, alkoxyated hexanediol diacrylate, dioxane glycol diacrylate, dioxane glycol diacrylate, cyclohexanone dimethanol di-

acrylate, diethylene glycol diacrylate and neopentyl glycol diacrylate.

**[0016]** Other suitable trifunctional acrylates include propoxylated glycerine triacrylate and propoxylated trimethylolpropane triacrylate.

**[0017]** Other higher functional acrylates include ditrimethylolpropane tetraacrylate, dipentaerythritol pentaacrylate, ethoxylated pentaerythritol tetraacrylate, methoxylated glycol acrylates and acrylate esters.

**[0018]** Furthermore, methacrylates corresponding to the above-mentioned acrylates may be used with these acrylates. Of the methacrylates, methoxypolyethylene glycol methacrylate, methoxytriethylene glycol methacrylate, hydroxyethyl methacrylate, phenoxyethyl methacrylate, cyclohexyl methacrylate, tetraethylene glycol dimethacrylate, and polyethylene glycol dimethacrylate.

**[0019]** It is noted that a plurality of base layers and/or a plurality of cover layers may be applied on the substrate. The sequence of layers as seen from the substrate may be different and the composition and properties of the substances and the thicknesses of the layers may vary. For example, one of the base layers may be transparent and an other one coloured or pigmented. The base layers may have a substance quantity of 10-30 g/m<sup>2</sup>, but higher or lower levels are conceivable.

**[0020]** The one or more cover layers may be relatively thick in order to provide sufficient thickness for embossing a visible texture, for example a wood pattern or the like. Furthermore, inclined side edges can be embossed in order to create V-grooves between panels that are made of the coated and embossed substrate and are placed next to each other. The inclined side edges can be made by means of an alternative manufacturing process, for example milling or the like. The one or more cover layers may have a substance quantity of 90-150 g/m<sup>2</sup>, but higher or lower levels are conceivable. The cover layer may be provided with anti-wear particles.

**[0021]** Before applying a new layer on a previous layer, the previous layer may be partly or fully cured. For adherence reasons it may be desired to cure the previous layer only partly.

**[0022]** The curable substances may be cured by free radical polymerization by means of radiation curing. A radiation curing process can be used to initiate cross-linking reactions among all reactive materials in the system by means of high energy electron beam or ultraviolet radiation. Creating free radicals for UV curing requires the use of photo-initiators as well as reactive monomers and pre-polymers. Photo-initiators decompose on exposure to UV light to produce initiating free radicals, which start the chain reaction until reactive ingredients become polymerized, solid and dry. A three dimensional network of hard solid dry coating is then formed. Photo-initiators can be grouped into 4 classes based on their chemical behavior on photolysis. Class 1: Aromatic ketone initiator functions via a H-atom abstraction process. Initiators commonly used in this class are Benzophenone; 4-phenyl Benzophenone and the like. Class 2: initiators under-

go a fragmentation on exposure to UV. The more widely used photo-initiators in this class are Benzoin, Benzoin ethers. Class 3: Tertiary amines/H-atoms Abstraction photo-initiators such as triethanolamine/benzophenone; methyl diethanolamine/ benzophenone. Class 4: photo-initiators derived from acetophenone, which functions by either H-atom abstraction process or fragmentation. The broadly used photo-initiators in this class are 2, 2 diethoxyacetophenone; [alpha][alpha] dichloroaceto, p-phenoxyphenone. Radiation pre-polymers can generally be categorized as Epoxy Acrylates; Urethane Acrylates; Unsaturated Acrylates; Polyester Acrylates; Polyether Acrylates and Vinyl/ Acrylic system. The selection of the reactive monomers, pre-polymers as well as photo-initiators will dictate the amount of cross-linking density of the layers. Other additives can also be used.

**[0023]** The first and/or second substance may also contain other additives, for instance flow and levelling additives for better spread and reduction of air entrapment while coating. Elimination of craters and fisheyes, reduction of orange peel and pinholes, enhancement of substrate wetting will increase the quality level of the coatings for further layers.

**[0024]** The invention is also related to a surface covering as defined in claim 14. The connecting means as defined in claim 15 may comprise cooperating tongues and grooves that are provided at side edges of surface coverings, for example. The advantage of the coating of the surface covering is that a backing layer can be relatively thin or even omitted.

**[0025]** The invention will hereafter be elucidated with reference to a drawing showing an embodiment of the invention very schematically.

**[0026]** Fig. 1 is a side view of an embodiment of a substrate which is coated by means of the method according to the invention.

**[0027]** Fig. 1 shows a surface covering in the form of a floor panel 1. The floor panel comprises a substrate 2, three base layers 3 and a cover layer 4. The cover layer 4 is thicker than each of the base layers 3. The base layer 3 may have a thickness of 5-25 μm and the cover layer 4 may have a thickness of 50-200 μm.

**[0028]** One of the base layers 3 may be replaced by a decorative layer (not shown) or a decorative pattern may be printed on the substrate 2 or on one of the base layers 3. The cover layer 4 may be a wear-resistant layer, possibly provided with anti-wear particles.

**[0029]** The substrate may be made of wood-containing materials like MDF, HDF, or the like, or plastic. Preferably, the substrate is made of a composition that comprises propylene-based elastomer and one of a polymer-free substance and a polymer-containing substance. This composition appears to be very compatible with a coating comprising polyurethane acrylate in terms of flexibility and strong adherence.

**[0030]** The base layers 3 and the cover layer 4 are applied onto the substrate 2 as substances that are mixtures of polyurethane acrylate and reactive diluent. Each

of the base layers 3 are applied by means of calendering or inert calendering or a roller coater or curtain coater. The viscosity of the curable substance of the base layers 3 may be 1000-10000 cP at 25 °C. The cover layer 4 is applied by means of calendering or inert calendering or a roller coater or a curtain coater, whereas the substance may have a viscosity of 100-2000 cP at 25 °C.

**[0031]** Before applying the first base layer 3 onto the substrate 2 the receiving surface of the substrate 2 is sanded and/or treated by plasma, corona, pyrolysis or the like. This may be performed each time before applying a next base layer 3 or the cover layer 4.

## Claims

1. A method of coating a substrate, comprising the steps of:

supplying a substrate,  
 applying at least a base layer of a first curable substance having a viscosity of 1000-10000 cP at 25 °C on the substrate,  
 applying at least a cover layer of a second curable substance having a viscosity of 100-2000 cP at 25 °C on the base layer, wherein the cover layer is thicker than the base layer,  
 wherein both the first and second substances comprise polyurethane acrylate and reactive diluent.

2. A method according to claim 1, wherein the reactive diluent comprises at least one of a monomer, oligomer and prepolymer.

3. A method according to claim 1 or 2, wherein polyurethane acrylate comprises at least one of aromatic polyurethane acrylate and aliphatic polyurethane acrylate.

4. A method according to one of the preceding claims, wherein the first curable substance is diluted less than the second curable substance and/or wherein the viscosity of the first substance is higher than of the second substance.

5. A method according to one of the preceding claims, wherein the first curable substance comprises more than 65 wt% polyurethane acrylate and less than 35 wt% reactive diluent and which is applied at 30-60°C, or wherein the first curable substance comprises more than 72 wt% polyurethane acrylate and less than 28 wt% reactive diluent and which is applied at 25-40°C.

6. A method according to one of the preceding claims, wherein the second curable substance comprises more than 50 wt% polyurethane acrylate and less

than 50 wt% reactive diluent.

7. A method according to claim 6, wherein the second curable substance comprises 55-75 wt% polyurethane acrylate and 25-45 wt% reactive diluent and which is applied at 30-60°C, or 60-72 wt% and 28-40 wt% at 30-45°C, respectively, or 75-80 wt% and 20-25 wt% at 35-40°C, respectively.

8. A method according to one of the preceding claims, wherein the base layer has a thickness of 5-25µm.

9. A method according to one of the preceding claims, wherein the cover layer has a thickness of 50-200µm.

10. A method according to one of the preceding claims, wherein the base layer is applied by means of calendering or a roller coater.

11. A method according to one of the preceding claims, wherein the cover layer is applied by means of calendering or curtain coating.

12. A method according to one of the preceding claims, wherein the first curable substance is at least partly cured before applying the cover layer.

13. A method according to one of the preceding claims, wherein the first and/or second substance are cured by means of irradiation.

14. A surface covering in the form of a sheet, a panel, a tile or a plank, in particular for covering a floor, wall, or ceiling in interior or exterior application, comprising a substrate which is coated by means of the method according to one of the preceding claims.

15. A surface covering according to claim 1, wherein the surface covering is provided with connecting means for connecting the surface covering to another surface covering.

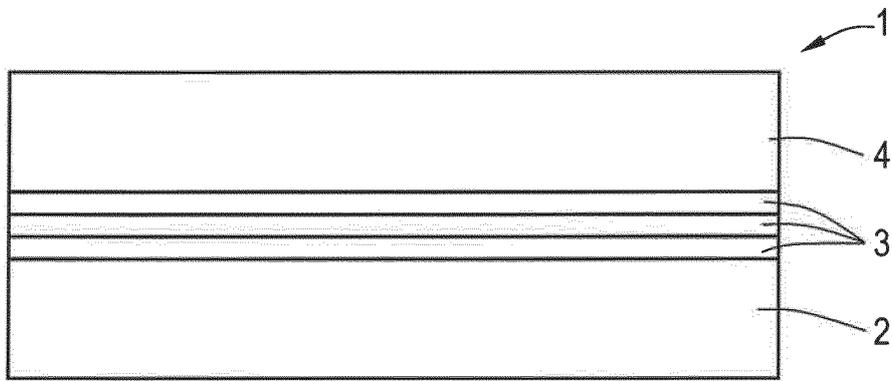


Fig.1



EUROPEAN SEARCH REPORT

Application Number  
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			B05D
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 20 August 2013	Examiner Riederer, Florian
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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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