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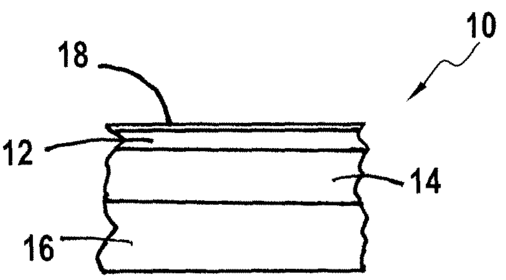
(54) **Title:** FIRE RETARDANT LAMINATE



(57) Abstract: A high pressure laminate includes a first layer (12) of resin impregnated paper and at least one layer (14,16) of fiber reinforced veil. Each layer of fiber reinforced veil includes binder and filler. The laminate is characterized by having a caloric value of lower than 3.0 MJ/kg when tested in accordance with ISO 1716. A method for producing this high pressure laminate is also provided.

FIRE RETARDANT LAMINATE

TECHNICAL FIELD AND INDUSTRIAL APPLICABILITY OF THE INVENTION

This invention relates generally to fire retardant, high pressure laminates and more particularly to a high pressure laminate complying with prEN 13823 and having a caloric value of lower than 3.0 MJ/kg when tested in accordance with ISO 1716.

BACKGROUND OF THE INVENTION

High pressure laminates (HPL) are well known in the art and HPL panels are used, for example, as wall linings, for furniture, facade cladding, bench tops and the like.

One of the most important parameters of HPL panels, especially in the building industry, is fire performance. Since 2003, all building materials in Europe must comply with prEN 13823 (reaction to fire tests for building products). This norm describes the Single Burning Item (SBI) test. A1 and A2 classification of additional caloric value measurement according to ISO 1716 is required.

State of the art HPL panels are made fire retardant by using fire retardant kraft paper or by using a fire retardant phenol-formaldehyde resin. State of the art FR-HPL products have achieved an SBI classification of as high as B (above 3.0 MJ/kg when tested under ISO 1716).

HPL manufacturers have a strong desire for an SBI A2 classified HPL panel. Such a classification would allow the manufacturers to expand the application range for their products and thereby penetrate additional markets. To date, this hasn't been achieved because no one has been able to meet the caloric value requirement and still achieve the desired mechanical properties and fire propagation characteristics. The present invention relates to the first HPL panel meeting all these requirements including those for A2 classification (below 3.0 MJ/kg when tested under ISO 1716).

The present invention relates to a novel laminate characterized by improved fire and impact resistance.

SUMMARY OF THE INVENTION

The high pressure laminate of the present invention comprises a first layer of resin impregnated paper and at least one layer of fiber reinforced veil. Each layer of fiber reinforced veil includes both a secondary binder and a filler. The high pressure laminate is characterized by having a caloric value of lower than about 3.0 MJ/kg when tested in accordance with ISO 1716.

The laminate may further include a second layer of resin impregnated paper. In such an embodiment the layer or layers of fiber reinforced veil are sandwiched between the first and second layers of resin impregnated paper.

In any of the possible embodiments the secondary binder is a heat curable resin. Suitable binders include but are not limited to self-crosslinkable polyacrylates, polyamide-amine epichlorohydrin resin (PAE), polyvinyl alcohol, acrylates, styrene acrylates, melamine-formaldehyde, urea-formaldehyde, phenol-formaldehyde, epoxy resin, unsaturated polyesters, crosslinkable acrylic resin, polyurethane resin, epichlorohydrin-polyaminopolyamide resins, epichlorohydrin-polyamine resins, epichlorohydrin-polyamide resins and mixtures thereof.

The filler is typically selected from a group consisting of metal hydroxides, metal carbonates, titanium dioxide, calcined clay, barium sulfate, magnesium sulfate, aluminum sulfate, zinc oxide, kaolin clay, chlorite, diatomite, feldspar, mica, nepheline syenite, pyrophyllite (aluminum silicate), silica, talc, wollastonite, montmorillonite (bentonite), hectorite, saponite, calcium carbonate, magnesium carbonate, aluminum oxide, iron oxide, magnesium hydroxide, glass micro beads and mixtures thereof.

In one embodiment, the filler is selected from the group of of metal hydroxides, metal carbonates and mixtures thereof. A mixture of calcium carbonate and aluminum hydroxide is a particularly useful filler for the present invention. This is particularly true when the binder is melamine-formaldehyde.

Other fillers include aluminum trihydrate, magnesium hydroxide, melamine cyanurate, halogenated additive, antimony trioxide, metal hydroxide, metal carbonate, titanium dioxide, calcined clay, barium sulfate, magnesium sulfate, aluminum sulfate, zinc oxide, kaolin clay, chlorite, diatomite, felspar, mica, nepheline syenite, pyrophyllite, silica, talc, wollastonite, montmorillonite, hectorite, saponite, magnesium carbonate, aluminum oxide, iron oxide, glass microbeads, ethylenediaminephosphate, guanidinephosphates, melamine borate, melamine (mono, pyro, poly) phosphate, ammonium (mono, pyro, poly) phosphate, dicyandiamide condensates, general intumescent systems (systems which foam during fire and therefore generate in situ an insulating layer) and mixtures thereof.

In one possible embodiment each layer of fiber reinforced veil includes between about 1 and about 95 weight percent reinforcement fibers about 5 and about 50 weight percent melamine-formaldehyde, between about 10 and about 80 weight percent calcium carbonate and about 20 and about 90 weight percent aluminum hydroxide.

The fiber reinforced veil may be woven or nonwoven. Where multiple layers of fiber reinforced veil are provided, they may all be woven, they may all be nonwoven or the layers may be a mixture of woven and nonwoven. The fiber reinforced veil includes fibers selected from a group consisting of glass fibers, basalt fibers, metal fibers, inorganic fibers, silica fibers, carbide fibers, nitride fibers, carbon fibers and mixtures thereof. Glass fibers utilized for the fiber reinforced veil may be selected from a group of materials consisting of boron-free glass, E-glass, ECR-glass, C-glass, AR-glass, S2-glass and mixtures thereof.

The high pressure laminate of the present invention may be made more aesthetically appealing when the first layer of resin impregnated paper is a melamine impregnated decor paper. Further, the product may include a radiation cured paint film or coating such as a UV cured paint film or an electron beam cured paint film on an exposed face of the first layer of resin impregnated paper. In yet another alternative the product may include a thermally cross-linked urethane acrylate paint layer on an exposed face of the first layer of the resin impregnated paper.

In accordance with yet another aspect of the present invention a method is provided for making a high pressure laminate. That method comprises pressing a first layer of resin impregnated paper and at least one layer of fiber reinforced veil together at a pressure of between about 525 N/m^2 and about 15,750 N/m^2 while simultaneously heating the layers to a temperature of between about 120 degrees C and about 220 degrees C to form a laminate. In addition the method includes the step of using a combination of secondary binder and filler to provide a caloric value of lower than 3.0 MJ/kg when the laminate is tested in accordance with ISO 1716.

The method may further include the selecting of the secondary binder from a group consisting of melamine-formaldehyde, phenol-formaldehyde, urea-formaldehyde, epoxy resin, unsaturated polyesters, cross-linkable acrylic resin, polyurethane resin, an epichlorohydrin-polyaminopolyamide resin, an epichlorohydrin-polyamine resin, an epichlorohydrin-polyamide resin and mixtures thereof. The filler may be selected from a group consisting of metal hydroxides, metal carbonates and mixtures thereof. In a particularly useful embodiment the filler is selected from a mixture of calcium carbonate and aluminum hydroxide.

In one possible embodiment the method includes the forming of the first layer of resin impregnated paper from melamine impregnated decor paper. In addition, the method may include the painting of an exposed face of the first layer of resin impregnated paper with a radiation cured paint. In yet another possible embodiment the method may include the painting of an exposed face of the first layer of resin impregnated paper with a thermally crosslinked urethane acrylate paint.

In another embodiment, the laminate of the present invention comprises a resin impregnated decorative layer, a fire barrier formed from a fiber reinforced veil and a layer of fiberboard.

The layer of fiberboard in the laminate may be generally described as a wood-based panel. The fiberboard may be constructed from a material selected from the group consisting of high density fiberboard, medium density fiberboard, oriented strand board, chipboard and mixtures thereof. In addition, the laminate may include a layer of resin impregnated overlay paper overlying the resin impregnated decorative paper and/or a resin impregnated backing layer underlying the layer of fiberboard. Both the resin impregnated decorative layer and the resin impregnated backing layer may be made from a decorative paper of a type known in the art.

In this embodiment, the fiber reinforced veil includes between about 5 to about 95 weight percent reinforcement fibers, about 5 to about 75 weight percent binder and about 0 to about 80 weight percent filler. Following impregnation and prior to pressing, the fiber reinforced veil has a weight per unit area of between about 20 and about 500 g/m^2.

The method of making the fiber board laminate comprises pressing a resin impregnated overlay layer, a resin impregnated decorative layer, a fire barrier formed from a fiber reinforced veil, a layer of fiberboard and a resin impregnated backing layer together at a pressure of between about 1050 N/m^2 and about 5250 N/m^2 while simultaneously heating to a temperature of between about 150 to about 225 degrees C for a time period of between about 10 to about 50 seconds. That method may be further described as including a step of providing a binder in the fiber reinforced veil selected from a group consisting of polyvinyl alcohol, acrylates, styrene acrylates, melamine-formaldehyde, urea-formaldehyde, phenol-formaldehyde, epoxy resin, unsaturated polyesters, crosslinkable acrylic resin, polyurethane resin, polyamide-amine epichlorohydrin resin and mixtures thereof.

The laminate may be used in a laminate flooring application wherein the laminate is formed from boards having a wood basis such as chipboard, fiberboard including high and medium density fiberboard, and oriented strand board. Additional applications for the laminate include, but are not limited to, wall linings, ceilings, interior shop fittings, and decoration panels such as those found in ships, trains, and buildings.

In the following description there is shown and described one possible embodiment of the invention simply by way of illustration of one of the modes best suited to carry out the invention. As it will be realized, the invention is capable of other different embodiments and its several details are capable of modification in various, obvious aspects all without departing from the invention. Accordingly, the drawings and descriptions will be regarded as illustrative in nature and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawing incorporated in and forming a part of this specification, illustrates several aspects of the present invention, and together with the description serves to explain certain principles of the invention. In the drawing:

Figure 1 is a side elevational view of one possible embodiment of the present invention.

Figure 2 is a side elevational view of a first alternative embodiment of the present invention.

Figure 3 is a side elevational view of yet another possible embodiment of the present invention.

Figure 4a is a total heat release graph comparing two representative examples of the present invention with two representative state of the art products.

Figure 4b is a heat release rate graph comparing the same two representative examples of the present invention with two representative state of the art products.

Figure 5 is a side elevational view of one possible embodiment of the present invention.

Fig. 6 shows the impact classification ratings using both the small ball impact test and the large ball impact test.

Reference will now be made in detail to the present preferred embodiment of the invention, an example of which is illustrated in the accompanying drawings.

DETAILED DESCRIPTION OF THE INVENTION

Three embodiments of the high pressure laminate 10 of the present invention are illustrated in Figures 1-3. The high pressure laminate 10 may be generally described as comprising a first layer of resin impregnated paper and at least one layer of fiber reinforced veil,

Each layer of fiber reinforced veil further includes a secondary binder and filler so that the high pressure laminate is characterized by having a caloric value of lower than 3.0 MJ/kg when tested in accordance with ISO 1716. The term "secondary binder" is defined as a binder which is applied in a second processing step which is discussed in more detail below.

As illustrated in the Figure 1 embodiment, the high pressure laminate 10 includes a first layer 12 of resin impregnated paper, such as melamine impregnated decor paper. In addition, the laminate 10 includes two layers 14, 16 of fiber reinforced veil.

Each layer 14, 16 of fiber reinforced veil is impregnated with a secondary binder and filler composition. The secondary binder is a heat curable resin. Typically, the secondary binder is selected from a group consisting of melamine-formaldehyde, phenol-formaldehyde, urea-formaldehyde, epoxy resin, unsaturated polyesters, cross-linkable acrylic resin, polyurethane resin, an epichlorohydrin-polyaminopolyamide resin, an epichlorohydrin-polyamine resin, an epichlorohydrin-polyamide resin and mixtures thereof.

The filler is selected from a group consisting of metal hydroxides, metal carbonates, titanium dioxide, calcined clay, barium sulfate, magnesium sulfate, aluminum sulfate, zinc oxide, kaolin clay, chlorite, diatomite, feldspar, mica, nepheline syenite, pyrophyllite (aluminum silicate), silica, talc, wollastonite, montmorillonite (bentonite), hectorite, saponite, calcium carbonate, magnesium carbonate, aluminum oxide, iron oxide, magnesium hydroxide, glass micro beads and mixtures thereof. Typically the filler is selected from a group consisting of metal hydroxides, metal carbonates and mixtures thereof. A mixture of calcium carbonate and aluminum hydroxide is particularly useful in the present invention. This is particularly true when used in conjunction with a melamine-formaldehyde binder. The particle size of the fillers typically ranges from about 0.3 μm to about 150 μm, more preferably between about 1 μm to about 75 μm, and most preferably between about 4 μm to about 50 μm.

The fiber reinforced veil includes reinforcing fibers selected from a group consisting of glass fibers, basalt fibers, inorganic fibers (carbide, nitride, etc.) and mixtures thereof. Glass fibers particularly useful in the present invention include E-glass (such as Advantex glass), ECR-glass, AR-glass, C-glass, M-glass, D-glass, S-glass, S2-glass and mixtures thereof. The fibers are typically chopped in lengths of between about 0.1 mm and 100 mm and may be in the forms of chopped strands, chopped rovings or chopped individual fibers or mixtures thereof. Where individual fibers are utilized, the diameter of those fibers is typically between about 3 and about 50 microns.

The fiber reinforced veils, prior to impregnation of the secondary binder and fillers, contain up to about 95 weight percent glass fibers, preferably between about

75 to about 95 weight percent glass fibers, more preferably between about 78 to about 93 weight percent glass fibers, and most preferably between about 80 to about 92.5 weight percent glass fibers. Preferably, the fiber reinforced veil layer includes E-glass fibers.

The fiber reinforced veil, prior to impregnation of the secondary binder composition and fillers, may include a binder, as mentioned above, preferably the binder is a polyvinyl alcohol. Preferably, the binder is present in the veil at a content of about 5 to about 25 percent by weight.

In the embodiment illustrated in Figure 1, the laminate 10 incorporates two layers 14, 16 of veil. Each veil layer 14, 16 may be woven or nonwoven. In the embodiment illustrated in Figure 1, both veil layers 14, 16 may be woven, both may be nonwoven or one may be woven while the other is nonwoven.

A particularly useful embodiment of the present invention incorporates one or more veil layers 14, 16 including between about 1 and about 95 weight percent reinforcement fibers, preferably between about 75 weight percent to about 95 weight percent reinforcement fibers, more preferably between about 78 to about 93 weight percent reinforcement fibers, most preferably between about 80 to about 92.5 weight percent reinforcement fibers, prior to impregnation of the secondary binder composition and fillers. The veil layers also contain between about 2 to about 50 weight percent, preferably between about 5 to about 25 weight percent melamine-formaldehyde secondary binder and at least one filler in the amount of between about 10 and about 80 weight percent, preferably between about 17.5 to about 65 weight percent calcium carbonate and about 20 to about 90 weight percent, preferably about 35 to about 70 weight percent aluminum hydroxide.

As further illustrated in Figure 1, the laminate 10 may be made more aesthetically pleasing by including a radiation curable paint such as an electron beam cured or UV cured paint film 18 on an otherwise exposed face of the first layer of resin impregnated paper 12. Alternatively, the layer 18 may comprise a thermally cross-linked urethane acrylate paint.

An alternative embodiment of the present invention is illustrated in Figure 2. In this embodiment, the high pressure laminate 10 includes a single fiber reinforced veil layer 20 sandwiched between first and second layers 22, 24 of resin impregnated paper. The laminate 10 of Figure 2 may also include a layer 26 of radiation cured paint such as an electron beam cured or UV cured paint film or a thermally cross-linked urethane acrylate paint. The layer 26 is, however, optional.

In still another embodiment illustrated in Figure 3, the laminate 10 may include a first layer 28 of resin impregnated paper, six intermediate layers 30, 32, 34, 36, 38, 40 of fiber reinforced veil and a second layer 42 of resin impregnated paper. The Figure 3 embodiment may also include an optional layer 44 comprising a radiation cured paint such as an electron beam or UV cured paint film or a thermally cross-linked urethane acrylate paint layer for enhanced aesthetic appearance.

It should be appreciated that the resin impregnated paper layers 22, 24, 28 and 42 of the embodiments illustrated in Figures 2 and 3 are similar or identical to the resin impregnated paper layer 12 of the first embodiment illustrated in Figure 1. Similarly, the fiber reinforced veil layers 20, 30, 32, 34, 36, 38, 40 of the embodiments illustrated in Figures 2 and 3 are also identical or similar to the veil layers 14, 16 of the Figure 1 embodiment. As illustrated, the laminate 10 of the present invention may include any number of fiber reinforced veil layers while still meeting the fire propagation, caloric value and mechanical properties of any particular end product application.

Typically, each fiber reinforced veil layer is a prepreg or ready-to-mold sheet of woven or nonwoven reinforcement fibers impregnated with a resin binder and stored for subsequent use such as the final construction of the laminate product by a manufacturer.

Any water-based, wet strength binder known in the art could be used. Useful binders include but are not limited to the following polyvinyl alcohol, (partially hydrolyzed) polyvinyl acetate, acrylic polymers and copolymers, crosslinkable acrylic polymers and copolymers, polymerizable polyfunctional N-methylol compounds, notably N-methylol ureas such as dimethylol urea and N-methylol melamine type resins, melamine formaldehyde, phenol formaldehyde, furfuryl formaldehyde, resorcinol formaldehyde, styrene butadiene copolymer latices, cationic polyamideepichlorohydrin, aminoresins, epoxyresins, polystyrene emulsion binder, polycarboxylic acid based binders, other latices and/or acrylic polymers or copolymers like acrylamide, ethylene vinyl acetate/vinyl chloride, alkyl acrylate polymer,styrene-butadiene rubber, acrylonitrile polymer, polyurethane resins, polyvinyl chloride, polyvinylidene chloride, copolymers of vinylidene chloride with other monomers, polyvinyl acetate, polyvinyl pyrrolidone, polyester resins, acrylate emulsion resin, styrene acrylate. More preferably, the binder is polyvinyl alcohol.

The prepreg is impregnated with the secondary binder and filler composition. The secondary binder and filler composition preferably includes between about 2 to about 30 weight percent glass, in addition to the glass already present in the prepreg, more preferably between about 3 to about 25 weight percent glass, and most preferably between about 4 to about 20 weight percent glass. The prepreg also contains between about 5 to about 25 weight percent secondary binder, preferably between about 7 to about 20 weight percent secondary binder, most preferably between about 8 to about 18 weight percent secondary binder. The prepreg also contains between about 50 to about 93 weight percent fillers, more preferably between about 55 to about 90 weight percent fillers and most preferably between about 60 to about 88 weight percent total fillers.

Typically the filler is a mixture of metal hydroxide and metal carbonate at a ratio of between about 1:0.01 and about 1:100. Preferably, the metal hydroxide aluminum hydroxide and is present in the prepreg the amount of between about 20 to about 90 weight percent, more preferably between about 30 to about 80 weight percent, and most preferably between about 35 to about 70 weight percent. The preferred metal carbonate is calcium carbonate and is present in the prepreg in the amount of about 10 to about 80 weight percent, more preferably about 15 to about 70 weight percent and most preferably between about 17.5 to about 65 weight percent.

The particle size of the fillers typically ranges from about 0.3 μm to about 150 μm, more preferably between about 1 μm to about 75 μm, and most preferably between about 4 μm to about 50 μm.

Following impregnation, and before pressing, a typical fiber reinforced veil prepreg will have a total weight per unit area of between about 250 g/m^2 and about 2000 g/m^2, a density of between about 500 kg/m^3 and about 2000 kg/m^3

The high pressure laminate 10 is constructed by pressing a first layer of resin impregnated paper and at least one layer of fiber reinforced veil together at a pressure of between about 525 N/m^2 and about 15,750 N/m^2 (about 5 and about 150 bar) while simultaneously heating the layers to a temperature of between about 120 degrees C and about 220 degrees C to form the laminate. In addition the method includes the step of using a combination of binder and filler to provide a caloric value of lower than 3.0 MJ/kg when the laminate is tested in accordance with ISO 1716. This allows one to produce an HPL panel or product with an SBI A2 classification.

In order to achieve this end, the secondary binder is selected from a group consisting of melamine-formaldehyde, phenol-formaldehyde, urea-formaldehyde, epoxy resin, unsaturated polyesters, cross-linkable acrylic resin, polyurethane resin, an epichlorohydrin-polyaminopolyamide resin, an epichlorohydrin-polyamine resin, an epichlorohydrin-polyamide resin and mixtures thereof. The filler is selected from a group of materials consisting of metal hydroxides, metal carbonates, titanium dioxide, calcined clay, barium sulfate, magnesium sulfate, aluminum sulfate, zinc oxide, kaolin clay, chlorite, diatomite, feldspar, mica, nepheline syenite, pyrophyllite (aluminum silicate), silica, talc, wollastonite, montmorillonite (bentonite), hectorite, saponite, calcium carbonate, magnesium carbonate, aluminum oxide, iron oxide, magnesium hydroxide, glass micro beads and mixtures thereof.

Typically, the filler is selected from a group consisting of metal hydroxides, metal carbonates and mixtures thereof. Calcium carbonate and aluminum hydroxide are particularly useful in this method.

In order to further enhance the aesthetic appeal of the product, the method may also include forming the first layer of resin impregnated paper from melamine impregnated decor paper. Further, the method may include painting an exposed face of the first layer of resin impregnated paper with electron beam cured paint. Alternatively the method may include painting an exposed face of the first layer of resin impregnated paper with a thermally crosslinked urethane acrylate paint.

Example 1

Five samples of a high pressure laminate of the present invention were prepared. In the first (Example 1), five fiber reinforced glass veils were sandwiched between two layers of melamine formaldehyde impregnated decorative paper.

The glass fiber utilized in the glass veils was E-glass having a fiber diameter of 11 microns and a length of 10 mm. The glass veils each had a weight per unit area of 100 g/m^2. The glass veils included a poly vinyl alcohol binder at a content of 16 weight percent.

The decorative paper layers each had a weight per unit area of 160 g/m^2 including 80 g/m^2 base weight paper and 80 g/m^2 melamine formaldehyde resin.

The stacked layers of glass veil were then impregnated with a secondary binder and filler formulation including 21weight percent phenol formaldehyde, 26 weight percent calcium carbonate and 53 weight percent aluminum hydroxide. The final glass veil weight was 1000 g/m^2.

The stacked layers were pressed together at a pressure of 100 kg/cm^2 at a temperature of 150 degrees C for 20 minutes to produce a 2.96 mm thick laminate.

In the second (Example 2), five fiber reinforced glass veils were sandwiched between a layer of melamine formaldehyde decorative paper and a layer of phenol formaldehyde impregnated kraft paper.

The glass fibers utilized in the Example 2 product were E-glass having a fiber diameter of 13 microns and a length of 11 mm. The glass veils each had a weight per unit area of 50 g/m^2 and included a poly vinyl alcohol binder at a content of 14 weight percent.

The stacked layers of glass veil were impregnated with a secondary binder and filler formulation of 15 weight percent melamine formaldehyde, 20 weight percent calcium carbonate and 65 weight percent aluminum hydroxide. The final glass veil weight was 900 g/m^2.

The stacked layers of the Example 2 product were pressed together at a pressure of 50 kg/cm^2 at a temperature of 145 degrees C for 20 minutes in order to produce a 3 mm thick laminate.

Additional Examples 3, 4 and 5 of the present invention are presented in Table 1 below along with Examples 1 and 2. Additionally, the Table includes corresponding measurements for representative state of the art HPL (std HPL) and state of the art FR-HPL (fire retardant HPL) products for purposes of comparison. Test results for each of these Examples 1-5 and the state of the art products std HPL and FR-HPL are presented (where available) in Table 2. Relevant total heat release (THR) and heat release rate (HRR) curves are illustrated respectively in Figures 4a and 4b.

TABLE 1

Process step	example 1	std HPL	fire retardant HPL 1	example 2	example 3	example 4	example 5
Glass veil manufacturing							
glass type	E-glass			E-glass	Advantex glass	Advantex glass	Advantex glass
fiber diameter (um)	11			13	11	11	11
fiber length(mm)	10			11	6	6	6
weight (g/m2)	100			50	70	90	105
bonded with:	poly vinyl aclohol			poly vinyl alcohol	poly vinyl alcohol	poly vinyl alcohol	poly vinyl alcohol
binder content (%)	16			14	11	11	11
Impregnation							
resin type	phenol formaldehyde	phenol formaldehyde	phenol formaldehyde + fire retardant additives	melamine formaldehyde	phenol formaldehyde	phenol formaldehyde	phenol formaldehyde
resin concentration (%)	21			15	9.5	9.1	10.4
calcium carbonate (%)	26			20	16.5	18.3	0
Aluminium hydroxide (%)	53			65	66.6	63.5	72.9
final pre-preg weight (g/m2)	1000			900	922	1004	630
Pressing							
pressure (kg/cm2)	100	70	70	50	75	75	75
temperature (° C)	150	160	160	145	150	150	150
pressing cycle time (min)	20	20	22	20	20	20	20
press package build-up for a 3 mm laminate	melamine formaldehyde impregnated decorative paper - 5 fiber reinforced prepregs - melamine formaldehyde impregnated decorative paper	melamine formaldehyde impregnated decorative paper - 12 phenolic resin impregnated kraft papers - melamine formaldehyde impregnated decorative paper	melamine formaldehyde impregnated decorative paper - 11 FR phenolic resin impregnated kraft papers - melamine formaldehyde impregnated decorative paper	melamine formaldehyde impregnated decorative paper - 5 fiber reinforced prepregs - phenol formaldehyde impregnated kraft paper	melamine formaldehyde impregnated decorative paper - 4 fiber reinforced prepregs - melamine formaldehyde impregnated decorative paper	melamine formaldehyde impregnated decorative paper - 4 fiber reinforced prepregs - melamine formaldehyde impregnated decorative paper	melamine formaldehyde impregnated decorative paper - 6 fiber reinforced prepregs - melamine formaldehyde impregnated decorative paper

decorative paper: weight = 160 g/m2
80 g/m2 base weight paper + 80 g/m2 melamine formaldehyde resin

TABLE 2

test	norm	example 1	std HPL	fire retardant HPL	example 2	example 3	example 4	example 5
thickness(mm)		2.96	2.99	2.75	3	2.2	2.4	2.3
density (kg/m3)		1849	1442	1500	1750	1847	1845	1870
2 hr water boiling test	EN 438							
visual observation		ok	ok	ok	ok	ok	ok	ok
thickness increase(%)		1,6	4,9	7	1.4	1.6	3	1.7
water absorption(%)		5,84	1,34	5	3.5	8.5	9.4	7.1
Dimensional stability	EN 438							
70 ± 2 °C; machine direction(%)		0,32	0,20	1.1				
70 ± 2 °C; cross direction(%)		0,32	0,45	2.3				
20 ± 2 °C; machine direction(%)		0,15	0,13	0.65				
20 ± 2 °C; cross direction(%)		0,18	0,30	0.98				
Flexural strength (Mpa)	ISO 178	87	180	179		54	62	86
Flexural modulus (Mpa)	ISO 178	14809	17652	23155		12200	11400	13600
Deflection((%)	ISO 178	0.7	1.11	0.8				
Tensile strength(Mpa)	ISO 3268	39	131	113				
Tensile modulus(Mpa)	ISO 3268	12410	18996	17634				
Elongation (%)	ISO 3268	0.4	0.74	0.68				
Impact F max (kN)	ISO 6603-2	1.9	1.9	1.2				
Impact energy (J)	ISO 6603-2	7.8	6.2	4.9				
Cone calorie measurements	ISO 5660	see THR HRR curves	see THR HRR curves	see THR HRR curves	see THR HRR curves			
Caloric value (MJ/kg)	ISO 1716	2.95	20.4	19.4	2.35	2.29	2.37	2
Limited Oxygen Index (%)	ISO 4589	100	40	46	100	100	100	100

Reference is now made to Figure 5 illustrating one possible embodiment of the laminate 46 of the present invention. As illustrated the laminate 46 includes a resin impregnated overlay paper 48 overlying a resin impregnated decorative layer 50. The decorative layer 50 overlies a first fire barrier formed from a fiber reinforced veil 52. The veil 52 overlies a layer of fiberboard 54. Finally, a backing layer 56 underlies the fiberboard 54. The laminate 46 may also include a second fire barrier, formed from a fiber reinforced veil 58, between the fiberboard 54 and the backing layer 56. This second veil 58 further enhances the fire retardant properties of the laminate 46 and insures that heat is transferred at about the same rate from the top or the bottom.

The fiber reinforced veil 52 may include fibers selected from a group consisting of glass fibers, basalt fibers, metal fibers, inorganic fibers, silica fibers, carbide fibers, nitride fibers, carbon fibers and mixtures thereof. Where glass fibers are utilized in the fiber reinforced veil, they may, for example, be selected from a group of fibers including boron-free glass, E-glass, ECR-glass, C-glass, AR-glass, S2-glass and mixtures thereof. Advantex® glass fibers, commercially available from Owens Corning (Toledo, OH), may be used.

The fiber reinforced veils 52 and 58 following resin impregnation includes between about 5 to about 95 weight percent reinforcement fibers, about 5 to about 75 weight percent resin/binder and 0 to about 80 weight percent filler. The binder utilized may be a B-stageable resin which may be reactivated during the pressing step to reach its final properties. The binder may be selected from a group of resins consisting of polyvinyl alcohol, acrylates, styrene acrylates, melamine-formaldehyde, urea-formaldehyde, phenol-formaldehyde, epoxy resin, unsaturated polyesters, crosslinkable acrylic resin, polyurethane resin, polyamide-amine epichlorohydrin resin and mixtures thereof. The filler utilized in the fiber reinforced veil 16 may be selected from a group consisting of aluminum trihydrate, magnesium hydroxide, melamine cyanurate, halogenated additive, antimony trioxide, metal hydroxide, metal carbonate, titanium dioxide, calcined clay, barium sulfate, magnesium sulfate, aluminum sulfate, zinc oxide, kaolin clay, chlorite, diatomite, felspar, mica, nepheline syenite, pyrophyllite, silica, talc, wollastonite, montmorillonite, hectorite, saponite, calcium carbonate, magnesium carbonate, aluminum oxide, iron oxide, glass microbeads, ethylenediaminephosphate, guanidinephosphates, melamine borate, melamine (mono, pyro, poly) phosphate, ammonium (mono, pyro, poly) phosphate, dicyandiamide condensates, general intumescent systems (systems which foam during fire and therefore generate in situ an insulating layer) and mixtures thereof. Advantageously, the fire barrier formed from the fiber reinforced veil 16 imparts improved fire retarding and impact characteristics to the laminate above and beyond those achieved with wood based laminates of the prior art not incorporating a fire barrier of fiber reinforced veil.

The fiber reinforced veils 52 and 58 are typically constructed from nonwoven glass fibers or mixed fibers. The veils 52,58 may include directionally oriented fibers if desired. Both continuous and chopped fibers may be utilized. The continuous fibers typically have a diameter of between about 3 and about 30. The chopped fibers typically have a length of between about 2 and about 100 mm and a diameter of between about 3 and about 30 μm. The fiber reinforced veil 52 following impregnation and prior to pressing typically has a weight per unit area of between about 20 and about 500 g/m^2.

The fiberboard 54 utilized in the present laminate is a wood based panel. The fiberboard 54 may, for example, be made from materials including high density fiberboard, medium density fiberboard, oriented strand board, chipboard and mixtures thereof.

The decorative layer 50 and backing layer 56 may be made from decorative paper as is known in the art. The overlay paper 48 may be made from cellulose as is also known in the art. The overlay paper 48, the decorative layer 48 and the backing layer 56 may all be impregnated with the same resin/binder as the fiber reinforced veil 46.

The laminate 46 is made by pressing the resin impregnated overlay layer 48, the resin impregnated decorative layer 50, the first fire barrier formed from the resin impregnated, fiber reinforced veil 52, the layer of fiberboard 54, the second fire barrier formed from the resin impregnated fiber reinforced veil 58 (if present) and the resin impregnated backing layer 56 together at a pressure of between about 1050 N/m^2 and about 5250 N/m^2 while simultaneously heating to a temperature of between about 150 to about 225 degrees C for a time period of between about 10 to about 50 seconds. Such processing may be completed in-line utilizing equipment that is presently available in the commercial marketplace.

Example 2

Table 3 shows fifteen samples of glass veil, prior to impregnation with additional binder and a flame retarder. All samples contain a poly(vinyl alcohol) (PVA) binder. The glass fibers in the veil include Advantex® glass fibers manufactured by Owens Corning, Toledo, OH, USA.

TABLE 3

SAMPLE	FIBER TYPE	glass Ni weight g/m2	binder perc %
1	Advantex; 11um-6 mm	47	15
2	Advantex; 11um-6 mm	46	15
3	Advantex; 11um-6 mm	47	15
4	Advantex; 11um-6 mm	47	15
5	Advantex; 11um-6 mm	46	15
6	Advantex; 11um-6 mm	46	15
7	Advantex; 11um-6 mm	47	15
8	Advantex/silica (85:15)	33	10
9	Advantex/silica (85:15)	54	10
10	Advantex/silica (85:15)	76	10
11	Advantex/silica (85:15)	48	10
12	Advantex/silica (85:15)	47	10
13	silica 100%	81	12
14	Advantex; 11um-6 mm	35	15
15	Advantex; 11um-6 mm	35	15

Table 4 shows samples 1-15 after they have been impregnated with additional binder and flame retardant. The "Add on" column shows the amount of fire retarder/filler per m2 impregnated into each sample.

TABLE 4

GLASS VEIL IMPREGNATION				
Sample No.	**Binder type**	**Flame retarder**	**Add on (g/M2)**	**End weight (g/M2)**
1	PVA	melamine phosphate	26	73
2	PVA	Melamine pyrophosphate	25	71
3	PVA	Melamine cyanurate	26	73
4	PVA	Ammonium polyphosphate	25	72
5	chlorine-acrylate	Aluminum trihydrate	25	71
6	chlorine-acrylate	ATH + APP	24	70
7	PVA	none	0	47
8	none	none	0	33
9	none	none	0	54
10	none	none	0	76
11	PVA	APP	23	71
12	PVA	Melamine polyphosphate	24	71
13	none	none	0	81
14	PVA	ATH	7	42
15	PVA	intumescent formulation	7	42

Table 5 shows the fire properties of samples 1-15 when each of the samples were exposed to flame. Samples 1-15 were lit above a Bunsen burner where the flame temperature reached about 950 °C. Distance to the flame was fixed, about 20 mm, for all the samples to ensure that the samples were exposed to the same temperature. Samples were observed for smoke development then the samples were removed from the flame and observed for self-extinguishing behavior.

TABLE 5

FIRE PROPERTIES			
Sample No.	**Smoke Development***	**Self-Extinguishing****	**Burn-through times (s)**
1	+	+++	40
2	+	+++	20
3	++	+++	3
4	+	+++	159
5	+	++	3
6	+	+++	130
7	-	+	1
8	--	+++	600
9	--	+++	170
10	--	+++	300
11	+	+++	250
12	+	+++	26
13	--	+++	>600
14	+	+++	1
15	++	+++	250

***Smoke development:**
--: no smoke development
-: hardly any smoke development
+: moderate smoke development
++: significant smoke development

****Self-extinguishing behavior**
+: poor self-extinguishing properties
++: moderate self-extinguishing properties
+++: significant self-extinguishing properties

The samples were then placed at a fixed distance, about 10 mm, above a Bunsen burner (Flame temperature at about 950 °C) and the time (in seconds) was recorded when the flame burned through the veil samples.

Flooring laminate examples

Specimens 7 and 14 were evaluated as an effective fire barrier in a laminate flooring panel. An unmodified flooring laminate was taken as a reference. The laminate flooring panels were evaluated on impact resistance and fire resistance.

Method of making the laminate flooring panel:

Specimens 7 and 14 were impregnated with melamine resin to ensure a good bonding with the decorative paper and with the fiber board. Specimens 7 and 14 were impregnated to final weights of approximately 150 g/m2.

The melamine-impregnated specimens 7 and 14 were pressed (function as a fire barrier between the decorative paper and the fiber board) onto the 8 mm high density fiber board (pressing conditions: 180 °C ; 40 kg/cm2; 20 s) to produce the laminate flooring panel. The final laminate flooring panel was subjected to two critical tests; impact resistance and fire resistance and tested with a reference laminate flooring panel, see Table 6.

TABLE 6

	Norm	Code A: Unmodified standard laminate flooring panel	Code B: Specimen 7 fire barrier laminate flooring panel	Code C: Specimen 14 fire barrier laminate flooring panel
Small ball impact (N)	EN 438	<15	16.82	18.84
Large ball impact (mm)	EN 438	<1600	>1600	>1600
Fire resistance	NF P 92-501	M3	M2	M2
Impact class (see fig 2)		IC1 or IC 2	IC 3	IC 3

As shown in Table 6, laminate flooring panels A, B and C were tested using the small and large ball impact tests described below. In the small ball impact test, the panels with their decorative surfaces were subjected to the impact of a 5 mm steel ball mounted at one end of a spring-loaded bolt. The minimum spring force (N) needed to cause visible damage was used to measure resistance to impact. In the large ball impact test, the laminate flooring panels A, B and C were covered with a sheet of carbon paper and subjected to the impact of a large steel ball (324 g; diameter of 42.8 mm) which was allowed to fall from a known height. In the large ball test, the height is increased in 50 mm intervals until the ball creates an impact imprint larger than 10 mm. This height determines the large ball impact resistance in mm. Impact resistance is expressed as the maximum drop height (mm) which can be achieved without incurring visible surface cracking or producing an imprint greater than a 10 mm diameter.

Fire resistance

The Epiradiateur test (NF P 92-501) is the national fire test for France and is mandatory for many building and construction materials.

The size of the specimens (7 and 14) tested was 300 mm x 400 mm x max 120 mm and the specimens were positioned at an incline of 45° on an 8 mm fixed, self-supporting frame. The specimens were ignited, from above and below, using an electrical radiator (inclined at 45°) at 500 W. Two butane pilot flames were used to ignite the fiber board panels above and below the specimen for 20 minutes.

Fig. 6 shows the impact classification ratings using both the small ball impact test and the large ball impact test.

The foregoing description of a preferred embodiment of the present invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Obvious modifications or variations are possible in light of the above teachings. For example, the second fire barrier and the backing layer could be combined into a single layer if desired.

The embodiments were chosen and described to provide the best illustration of the principles of the invention and its practical application to thereby enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally and equitably entitled. The drawings and preferred embodiment do not and are not intended to limit the ordinary meaning of the claims and their fair and broad interpretation in any way.

WHAT IS CLAIMED

1. A high pressure laminate (10), comprising:

a first layer of resin impregnated paper (12); and

at least one layer of fiber reinforced veil (14), each layer of fiber reinforced veil being impregnated with a secondary binder and at least one filler;

said high pressure laminate being characterized by having a caloric value of lower than about 3.0 MJ/kg when tested in accordance with ISO 1716.

2. The laminate of claim 1 including a second layer of resin impregnated paper (24), said at least one layer of fiber reinforced veil being sandwiched between said first and second layers (22,24) of resin impregnated paper.

3. The laminate of claim 1, wherein said secondary binder is a heat curable resin.

4. The laminate of claim 3 wherein said secondary binder is selected from a group consisting of melamine-formaldehyde, phenol-formaldehyde, urea-formaldehyde, epoxy resin, unsaturated polyesters, cross-linkable acrylic resin, polyurethane resin, an epichlorohydrin-polyaminopolyamide resin, an epichlorohydrin-polyamine resin, an epichlorohydrin-polyamide resin and mixtures thereof.

5. The laminate of claim 3, wherein said filler is selected from a group consisting of metal hydroxides, metal carbonates, titanium dioxide, calcined clay, barium sulfate, magnesium sulfate, aluminum sulfate, zinc oxide, kaolin clay, chlorite, diatomite, feldspar, mica, nepheline syenite, pyrophyllite, silica, talc, wollastonite, montmorillonite, hectorite, saponite, calcium carbonate, magnesium carbonate, aluminum oxide, iron oxide, magnesium hydroxide, glass micro beads and mixtures thereof.

6. The laminate of claim 1, wherein said filler is selected from a group consisting of metal hydroxides, metal carbonates and mixtures thereof.

7. The laminate of claim 6, wherein said mixtures of metal hydroxides to metal carbonates are provided at a ratio of between about 1:0.01 and about 1:100.

8. The laminate of claim 1, wherein said filler is selected from a mixture of calcium carbonate and aluminum hydroxide.

9. The laminate of claim 8 wherein said secondary binder is melamine-formaldehyde.

10. The laminate of claim 9, wherein each said layer of fiber reinforced veil following impregnation includes between about 1 and about 95 weight percent reinforcement fibers, about 2 and about 50 weight percent melamine-formaldehyde, between about 1 and about 85 weight percent calcium carbonate and about 1 and about 85 weight percent aluminum hydroxide.

11. The laminate of claim 10 wherein each said layer of fiber reinforced veil following impregnation and prior to pressing has a weight per unit area of between about 250 g/m^2 and about 2000 g/m^2 and a density of between about 500 kg/m^3 and about 2000 kg/m^3.

12. The laminate of claim 10, wherein said reinforcement fibers are glass fibers selected from a group consisting of E-glass, ECR-glass, AR-glass, M-glass, D-glass, C-glass, S-glass, S2-glass and mixtures thereof.

13. The laminate of claim 1 wherein said at least one layer of fiber reinforced veil is woven.

14. The laminate of claim 1, wherein said at least one layer of fiber reinforced veil is nonwoven.

15. The laminate of claim 1, including at least two layers of fiber reinforced veil wherein a first layer of said two layers is woven and a second layer of said two layers is nonwoven.

16. The laminate of claim 1, wherein said at least one fiber reinforced veil includes reinforcing fibers selected from a group consisting of glass fibers, basalt fibers, inorganic fibers and mixtures thereof.

17. The laminate of claim 1, wherein said at least one fiber reinforced veil includes chopped glass fibers

18. The laminate of claim 17, wherein said chopped glass fibers include chopped glass strands, chopped glass rovings, individual chopped glass fibers and mixtures thereof.

19. The laminate of claim 1, wherein said first layer of resin impregnated paper is a melamine impregnated decor paper.

20. The laminate of claim 1, further including a radiation cured paint film on an exposed face of said first layer of resin impregnated paper.

21. The laminate of claim 1, further including a thermally cross-linked urethane acrylate paint layer on an exposed face of said first layer of resin impregnated paper.

22. A fiber reinforced veil comprising a secondary binder and at least one filler; wherein said veil has a caloric value of lower than about 3.0 MJ/kg when tested in accordance with ISO 1716.

23. The fiber reinforced veil of claim 22, wherein said secondary binder is selected from the group consisting of melamine-formaldehyde, phenol-formaldehyde, urea-formaldehyde, epoxy resin, unsaturated polyesters, cross-linkable acrylic resin, polyurethane resin, an epichlorohydrin-polyaminopolyamide resin, an epichlorohydrin-polyamine resin, an epichlorohydrin-polyamide resin and mixtures thereof.

24. The fiber reinforced veil of claim 22, further comprising a binder selected from the group consisting of polyvinyl alcohol, (partially hydrolyzed) polyvinyl acetate, acrylic polymers and copolymers, crosslinkable acrylic polymers and copolymers, polymerizable polyfunctional N-methylol compounds, notably N-methylol ureas such as dimethylol urea and N-methylol melamine type resins, melamine formaldehyde, phenol formaldehyde, furfuryl formaldehyde, resorcinol formaldehyde, styrene butadiene copolymer latices, cationic polyamideepichlorohydrin, aminoresins, epoxyresins, polystyrene emulsion binder, polycarboxylic acid based binders, other latices and/or acrylic polymers or copolymers like acrylamide, ethylene vinyl acetate/vinyl chloride, alkyl acrylate polymer,styrene-butadiene rubber, acrylonitrile polymer, polyurethane resins, polyvinyl chloride, polyvinylidene chloride, copolymers of vinylidene chloride with other monomers, polyvinyl acetate, polyvinyl pyrrolidone, polyester resins, acrylate emulsion resin, and styrene acrylate.

25. The fiber reinforced veil of claim 22, wherein said filler is selected from a group consisting of metal hydroxides, metal carbonates, titanium dioxide, calcined clay, barium sulfate, magnesium sulfate, aluminum sulfate, zinc oxide, kaolin clay, chlorite, diatomite, feldspar, mica, nepheline syenite, pyrophyllite, silica, talc, wollastonite, montmorillonite, hectorite, saponite, calcium carbonate, magnesium carbonate, aluminum oxide, iron oxide, magnesium hydroxide, glass micro beads and mixtures thereof.

26. The fiber reinforced veil of claim 22, wherein said fiber reinforced veil includes reinforcing fibers selected from a group consisting of glass fibers, basalt fibers, inorganic fibers and mixtures thereof.

27. A method of making a high pressure laminate, comprising:

pressing a first layer of resin impregnated paper and at least one layer of fiber reinforced veil together at a pressure and temperature sufficient to laminate said paper and said at least one layer of veil together; and

impregnating said paper and said fiber reinforcing veil with a secondary binder and at least one filler to provide a caloric value of lower than 3.0 MJ/kg when said laminate is tested in accordance with ISO 1716.

28. The method of claim 27 wherein said step of pressing said paper and said veil together further includes pressing said paper and said veil together at a pressure of between about 525 N/ N/m^2 and about 15,750 N/m^2 and simultaneously heating said paper and said veil at a temperature of between about 120 degrees C and about 220 degrees C.

29. The method of claim 27 including selecting said secondary binder from a group consisting of melamine-formaldehyde, phenol-formaldehyde, urea-formaldehyde, epoxy resin, unsaturated polyesters, cross-linkable acrylic resin, polyurethane resin, an epichlorohydrin-polyaminopolyamide resin, an epichlorohydrin-polyamine resin, an epichlorohydrin-polyamide resin and mixtures thereof.

30. The method of claim 29, including selecting said filler from a group consisting of metal hydroxides, metal carbonates, titanium dioxide, calcined clay, barium sulfate, magnesium sulfate, aluminum sulfate, zinc oxide, kaolin clay, chlorite, diatomite, feldspar, mica, nepheline syenite, pyrophyllite, silica, talc, wollastonite, montmorillonite, hectorite, saponite, calcium carbonate, magnesium carbonate, aluminum oxide, iron oxide, magnesium hydroxide, glass micro beads and mixtures thereof.

31. The method of claim 29, including selecting said filler from a group consisting of metal hydroxides, metal carbonates and mixtures thereof.

32. The method of claim 29, including selecting said filler from a mixture of calcium carbonate and aluminum hydroxide.

33. The method of claim 27, including selecting said filler from a group consisting of metal hydroxides, metal carbonates and mixtures thereof.

34. The method of claim 27, including selecting said filler from a mixture of calcium carbonate and aluminum hydroxide.

35. The method of claim 27, further including forming said first layer of resin impregnated paper from melamine impregnated decor paper.

36. The method of claim 27, further including painting an exposed face of said first layer of resin impregnated paper with radiation cured paint.

37. The method of claim 27 further including painting an exposed face of said first layer of resin impregnated paper with a thermally crosslinked urethane acrylate paint.

38. A fire retardant laminate (46), comprising:

a resin impregnated decorative layer (50);
a first fire barrier formed from a fiber reinforced veil (52); and
a layer of fiberboard (54).

39. The laminate of claim 38, wherein said first fiber reinforced veil (52) includes fibers selected from a group consisting of glass fibers, basalt fibers, metal fibers, inorganic fibers, silica fibers, carbide fibers, nitride fibers, carbon fibers and mixtures thereof.

40. The laminate of claim 38, wherein said first fiber reinforced veil (52) includes glass fibers selected from a group of fibers including boron-free glass, E-glass, ECR-glass, C-glass, AR-glass, S2-glass and mixtures thereof.

41. The laminate of claim 38, wherein said first fiber reinforced veil (52) includes a binder comprising a B-stageable resin.

42. The laminate of claim 38, wherein said first fiber reinforced veil (52) includes a binder selected from a group consisting of polyvinyl alcohol, acrylates, styrene acrylates, melamine-formaldehyde, urea-formaldehyde, phenol-formaldehyde, epoxy resin, unsaturated polyesters, crosslinkable acrylic resin, polyurethane resin, polyamide-amine epichlorohydrin resin and mixtures thereof.

43. The laminate of claim 38, wherein said first fiber reinforced veil (52) includes a filler selected from a group consisting of aluminum trihydrate, magnesium hydroxide, melamine cyanurate, halogenated additive, antimony trioxide, metal hydroxide, metal carbonate, titanium dioxide, calcined clay, barium sulfate, magnesium sulfate, aluminum sulfate, zinc oxide, kaolin clay, chlorite, diatomite, felspar, mica, nepheline syenite, pyrophyllite, silica, talc, wollastonite, montmorillonite, hectorite, saponite, calcium carbonate, magnesium carbonate, aluminum oxide, iron oxide, glass microbeads, ethylenediaminephosphate, guanidinephosphates, melamine borate, melamine (mono, pyro, poly) phosphate, ammonium (mono, pyro, poly) phosphate, dicyandiamide condensates, general intumescent systems and mixtures thereof.

44. The laminate of claim 38, wherein said first fiber reinforced veil (52) is nonwoven.

45. The laminate of claim 38, further including a second fire barrier formed from a fiber reinforced veil (52), said layer of fiberboard (54) being sandwiched between said first and second fire barriers.

46. The laminate of claim 45, wherein said fiber reinforced veils (52,58) of said first and second fire barriers following resin impregnation include between about 5 to about 95 weight percent reinforcement fibers, about 5 to about 75 weight percent binder and 0 to about 80 weight percent filler.

47. The laminate of claim 46, wherein said fiber reinforced veils (52,58) of said first and second fire barriers include a resin binder selected from a group consisting of polyvinyl alcohol, acrylates, styrene acrylates, melamine-formaldehyde, urea-formaldehyde, phenol-formaldehyde, epoxy resin, unsaturated polyesters, crosslinkable acrylic resin, polyurethane resin, polyamide-amine epichlorohydrin resin and mixtures thereof.

48. The laminate of claim 47, wherein said fiber reinforced veils (52,58) of said first and second fire barriers include a filler selected from a group consisting of aluminum trihydrate, magnesium hydroxide, melamine cyanurate, halogenated additive, antimony trioxide, metal hydroxide, metal carbonate, titanium dioxide, calcined clay, barium sulfate, magnesium sulfate, aluminum sulfate, zinc oxide, kaolin clay, chlorite, diatomite, felspar, mica, nepheline syenite, pyrophyllite, silica, talc, wollastonite, montmorillonite, hectorite, saponite, calcium carbonate, magnesium carbonate, aluminum oxide, iron oxide, glass microbeads, ethylenediaminephosphate, guanidinephosphates, melamine borate, melamine (mono, pyro, poly) phosphate, ammonium (mono, pyro, poly) phosphate, dicyandiamide condensates, general intumescent systems and mixtures thereof.

49. The laminate of claim 46, wherein said fiber reinforced veils (52,58) of said first and second fire barriers following impregnation and prior to pressing have a weight per unit area of between about 20 and about 500 g/m^2.

50. The laminate of claim 38, wherein said layer of fiberboard (54) is a wood-based panel.

51. The laminate of claim 38, wherein said layer of fiberboard (54) is selected from a group of materials consisting of high density fiberboard, medium density fiberboard, oriented strand board, chipboard and mixtures thereof.

52. The laminate of claim 38, further including a layer of resin impregnated overlay paper (48) overlying said resin impregnated decorative layer (50) and a resin impregnated backing layer (56) underlying said layer of fiberboard (54).

53. The laminate of claim 52, further including a resin impregnated backing layer (56) underlying said layer of fiberboard (54).

54. The laminate of claim 53, wherein said resin impregnated decorative layer (50) and said resin impregnated backing layer (56) are both made from decorative paper.

55. The laminate of claim 38, wherein said laminate (46) is a flooring laminate.

56. The laminate of claim 38, wherein said laminate (46) is classified in impact class 3 (IC3).

57. A method of making a fire retardant laminate (46), comprising:

pressing a resin impregnated overlay layer (48), a resin impregnated decorative layer (50), a fire barrier formed from a resin impregnated, fiber reinforced veil (52), a layer of fiberboard (54) and a resin impregnated backing layer (56) together at a pressure of between about 1050 N/m^2 and about 5250 N/m^2 while simultaneously heating to a temperature of between about 150 to about 225 degrees C for a time period of between about 10 to about 50 seconds.

58. The method of claim 57, further including a step of providing a resin binder in said fiber reinforced veil (52) selected from a group consisting of polyvinyl alcohol, acrylates, styrene acrylates, melamine-formaldehyde, urea-formaldehyde, phenol-

formaldehyde, epoxy resin, unsaturated polyesters, crosslinkable acrylic resin, polyurethane resin, polyamide-amine epichlorohydrin resin and mixtures thereof.

59. The method of claim 58, further including a step of providing a filler in said fiber reinforced veil (52) selected from a group consisting of aluminum trihydrate, magnesium hydroxide, melamine cyanurate, halogenated additive, antimony trioxide, metal hydroxide, metal carbonate, titanium dioxide, calcined clay, barium sulfate, magnesium sulfate, aluminum sulfate, zinc oxide, kaolin clay, chlorite, diatomite, felspar, mica, nepheline syenite, pyrophyllite, silica, talc, wollastonite, montmorillonite, hectorite, saponite, calcium carbonate, magnesium carbonate, aluminum oxide, iron oxide, glass microbeads and mixtures thereof.

60. The method of claim 57, including providing a second fire barrier formed from a resin impregnated, fiber reinforced veil (52) between said layer of fiberboard (54) and said resin impregnated backing layer (56)

FIG.1

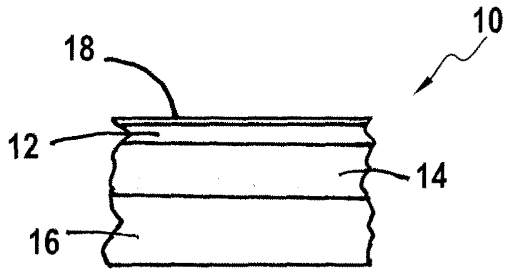


FIG.2

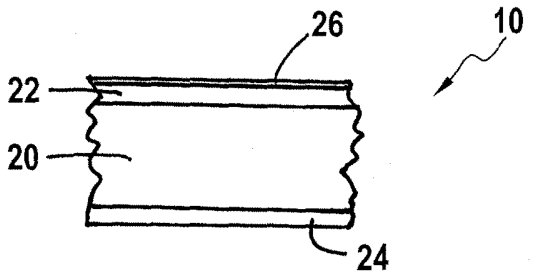
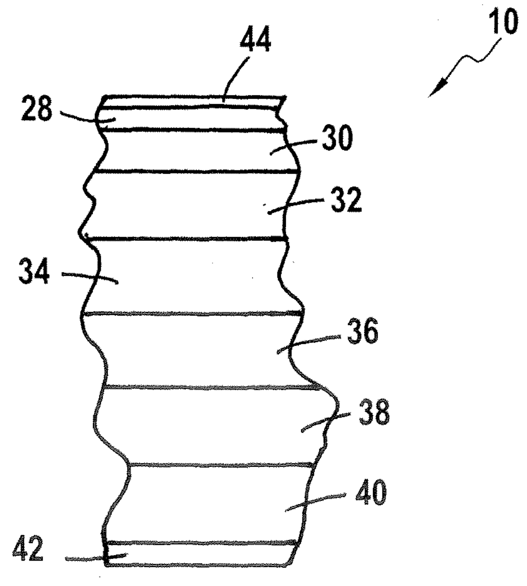


FIG.3



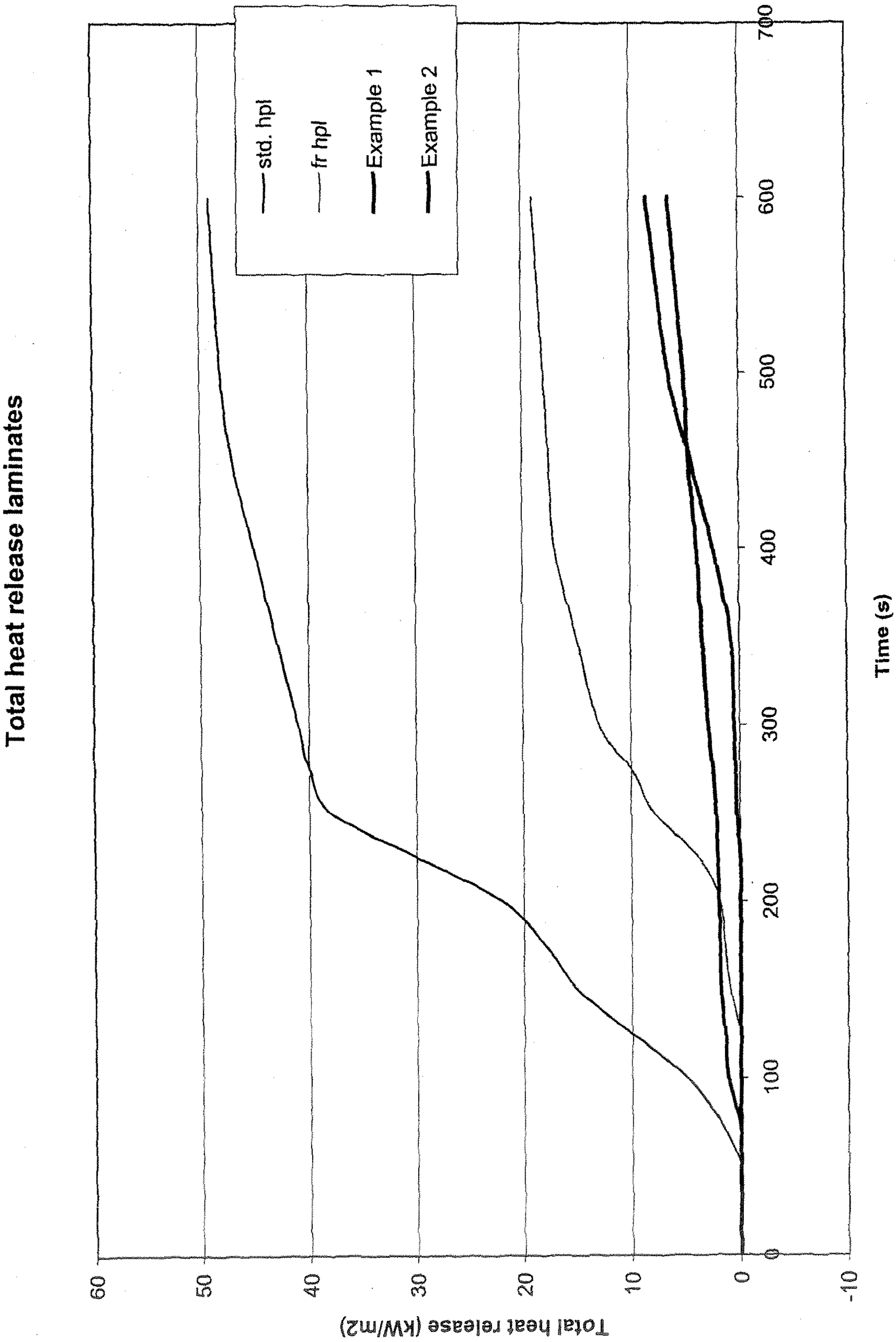

Total heat release laminates
std. hpl
fr hpl
Example 1
Example 2
Time (s)
Total heat release (kW/m2)
0
100
200
300
400
500
600
700
60
50
40
30
20
10
0
-10

FIG.4A

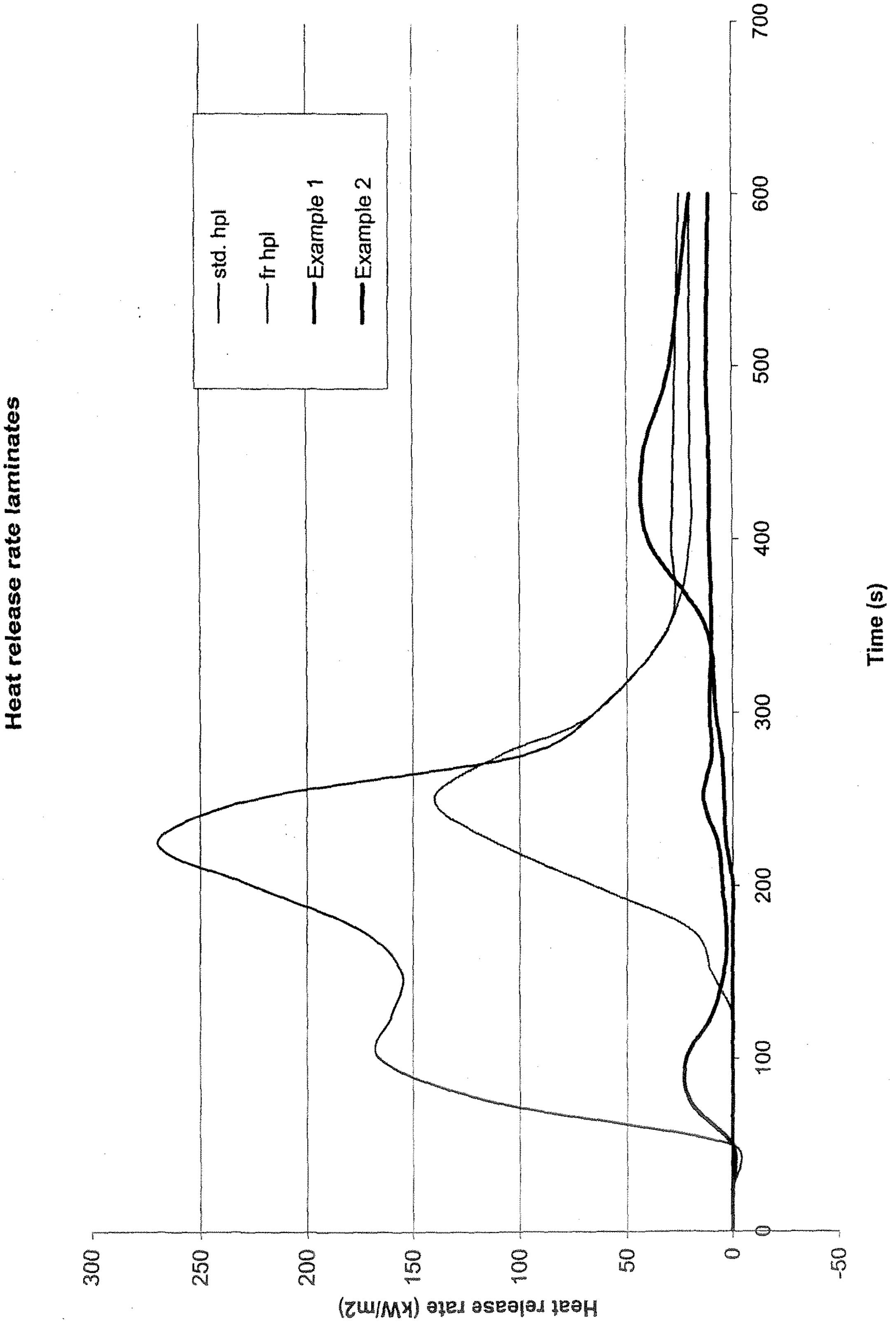

Heat release rate laminates
Heat release rate (kW/m2)
300
250
200
150
100
50
0
-50
Time (s)
0
100
200
300
400
500
600
700
std. hpl
fr hpl
Example 1
Example 2

FIG.4B

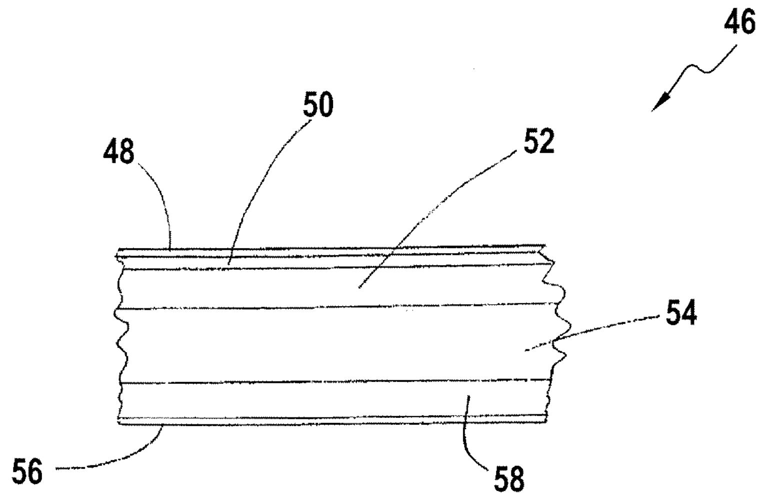

46
50
48
52
54
56
58

FIG.5

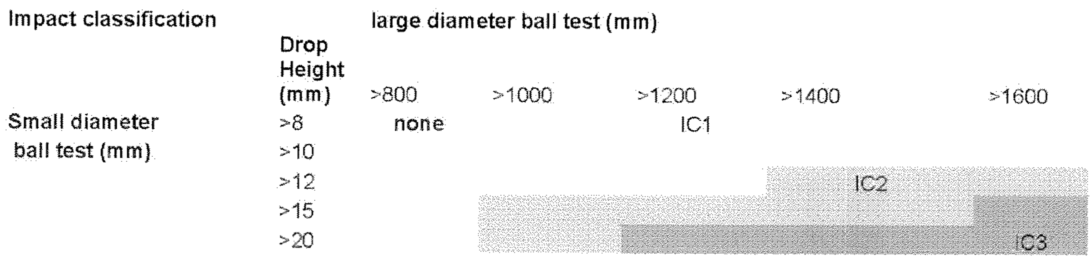

Impact classification
large diameter ball test (mm)
Drop Height (mm)
>800
>1000
>1200
>1400
>1600
Small diameter ball test (mm)
>8
>10
>12
>15
>20
none
IC1
IC2
IC3

FIG.6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2006/061194

A. CLASSIFICATION OF SUBJECT MATTER
INV. B32B17/04 B44C5/04 C08J5/04 B32B27/04

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)
B32B B44C C08J

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 practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 899 092 A (SUMITOMO BAKELITE COMPANY LIMITED) 3 March 1999 (1999-03-03)	1-5,9, 11,12, 14, 16-19, 22,23, 25-27, 29,30,35
	abstract; examples	
Y	paragraphs [0007] - [0011], [0019] - [0022]	1-60

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
22 May 2006	30/05/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Hutton, D

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2006/061194

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 2003/022577 A1 (KIM KWANG-MIN ET AL) 30 January 2003 (2003-01-30) abstract; figures	1-5,9, 11-14, 16-19, 22-27, 32,35, 38-44, 50,51
Y	paragraphs [0006], [0007], [0032] - [0075], [0082] - [0087]	1-60
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Y	EP 1 134 074 A (DSM N.V; PERSTORP AB) 19 September 2001 (2001-09-19) examples; table 3 claims; example III	6-8
X	US 2004/197468 A1 (GEEL PAUL ET AL) 7 October 2004 (2004-10-07) examples	22
Y	US 2002/013391 A1 (HUUSKEN ROBERT) 31 January 2002 (2002-01-31) figures; example 5	20,21, 36,37

INTERNATIONAL SEARCH REPORT

Information on patent family members

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