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(54) Title: CORRUGATED BOARD

(57) Abstract: The present invention provides corrugated board wherein one exterior side is coated with a water vapor barrier, a layer that is essentially impermeable to water vapor, and the second exterior side is coated with an oil barrier, a layer that is essentially impermeable to oil, a process for preparing the coated corrugated board, corrugated board boxes obtainable from the corrugated board of the present invention and the use of these corrugated board boxes for handling and storing goods under conditions of high relative humidity.

CORRUGATED BOARD

The present invention refers to corrugated board wherein one exterior side (outer liner) is coated with a layer, that is essentially impermeable to water vapor (water vapor barrier), and the second exterior side (outer liner) is coated with a layer, that is essentially impermeable to oil (oil barrier), to a process for preparing the coated corrugated board, to corrugated board boxes obtainable from the corrugated board of the present invention and to the use of these corrugated board boxes for handling and storing goods under conditions of high relative humidity.

It is well-known to handle and store goods, such as food, in some kind of container, for example in corrugated board boxes.

Under certain circumstances, the corrugated board box is handled or stored under conditions of high relative humidity, for example 70 to 95% relative humidity. This can be the case, when storing food in so-called chiller rooms, i.e. rooms having a temperature well below room temperature, but not freezing, and a high relative humidity. This can also be the case when storing food in countries having a tropical climate.

The corrugated board boxes are usually arranged in a palette, which can be transported easily. A typical dimension of a corrugated box is 40 cm long x 30 cm wide x 25 cm high. A palette will typically have 3 x 3 boxes and 7 high. This palette of boxes has to be taped together to prevent the boxes from falling over during transportation. Thus the tape adhesiveness is an important factor in the performance of these boxes.

Under conditions of high relative humidity the strength of corrugated board boxes decreases and bulging of the stacked boxes can occur.

Thus, it is one object of the present invention to provide corrugated board boxes, which show improved strength and adhesion to adhesive tape under conditions of high relative humidity and which are also recyclable and repulpable.

This object is solved by the corrugated board according to claim 1, the process according to claim 4, and the corrugated board boxes according to claim 5.

The corrugated board of the present invention is characterized in that one exterior side (outer liner) is coated with a layer, that is essentially impermeable to water vapor (water vapor barrier), and the second exterior side (outer liner) is coated with a layer, that is essentially impermeable to oil (oil barrier).

The layer that is essentially impermeable to water vapor (water vapor barrier) can be any layer comprising at least one polymer and optionally a wax, which layer is essentially impermeable to water vapor.

Preferably, the polymer is an acrylic polymer. Acrylic polymers can be polymers formed from at least one acrylic monomer and optionally other ethylenically unsaturated monomers. The term acrylic polymer shall also encompass acrylic core shell polymers.

Examples of acrylic monomers are (meth)acrylic acid and alkali or ammonium salts thereof, (meth)acrylamide, (meth)acrylonitrile, alkyl (meth)acrylates such as ethyl (meth)acrylate, butyl (meth)acrylate, hexyl (meth)acrylate or 2-ethylhexyl (meth)acrylate, di(alkylamino)alkyll (meth)acrylates such as dimethylaminoethyl acrylate or diethylaminoethyl acrylate and amides formed from di(alkylamino) alkylamines and (meth)acrylic acid.

Examples of other ethylenically unsaturated monomers are styrene monomers such as styrene, vinyl monomers such as vinyl alcohol, vinyl chloride or vinyl acetate, olefin monomers such as ethylene, propylene, butadiene or isoprene, and maleic monomers such as maleic acid, maleic anhydride or maleimide.

Preferred acrylic polymers are formed from at least one acrylic and one styrene monomer.

More preferably, the polymer is an acrylic core shell polymer. Acrylic core shell polymers comprise an acrylic polymer and stabilizing polymer, wherein the acrylic polymer is formed in the presence of the stabilizing polymer.

The acrylic polymer of the acrylic core shell polymer can have a weight average molecular weight (M_W) of from 75'000 g/mol to 350'000 g/mol, preferably from 80'000 g/mol to 200'000 g/mol, more preferably from 90'000 g/mol to 150'000 g/mol, as determined by gel permeation

chromatography, and a glass transition temperature (T_g) of below 50 °C, preferably of below 30 °C, more preferably of below 20 °C.

Preferably, the acrylic polymer of the acrylic core shell polymer is formed from at least one acrylic monomer and at least one styrene monomer. The weight ratio of styrene monomer/acrylic monomer of the acrylic polymer of the core shell polymer can be from 1/99 to 99/1, preferably from 20/80 to 80/20, more preferably from 50/50 to 60/40. Examples of acrylic polymers of the core shell polymers are copolymers formed from 50/50 (w/w) styrene/butyl acrylate, from 55/45 (w/w) styrene/butylacrylate, from 60/40 (w/w) styrene/2-ethylhexyl acrylate, from 30/30/40 (w/w/w) styrene/methyl methacrylate/2-ethyl-hexyl acrylate and from 55/45 (w/w) styrene/2-ethylhexyl acrylate.

A preferred acrylic polymer of the core shell polymer is 55/45 (w/w) styrene/2-ethylhexyl acrylate having a weight average molecular weight (M_W) of around 100'000 g/mol, as determined by gel permeation chromatography, and a glass transition temperature (T_g) of about 15 °C.

The stabilizing polymer can have a weight average molecular weight (M_W) of from 2'000 g/mol to 50'000 g/mol, preferably from 3'000 g/mol to 20'000 g/mol, more preferably from 6'000 g/mol to 10'000 g/mol, and a glass transition temperature (T_g) of of from 75 to 150 °C, preferably of from 85 to 120 °C, more preferably of from 95 to 110 °C. Preferably, the stabilizing polymer is also an acrylic polymer.

Examples of stabilizing polymers are 65/35 (w/w) styrene/acrylic acid, ammonium salt; 43/43/14 (w/w/w) isobutyl methacrylate/methyl methacrylate/acrylic acid, ammonium salt; 43/43/14 (w/w/w) butyl acrylate/methyl methacrylate/acrylic acid, ammonium salt; and 80/20 (w/w) ethylene/acrylic acid, ammonium salt.

An example of a stabilizing polymer is 65/35 (w/w) styrene acrylic acid, ammonium salt copolymer having a weight average molecular weight (M_W) of 8'000 g/mol, as determined by gel permeation chromatography, and a glass transition temperature (T_g) of about 105 °C.

The weight ratio of stabilizing polymer/acrylic polymer of the acrylic core shell polymer is 10/90 to 90/10. Preferably, it is 10/90 to 60/40. More preferably, it is 20/80 to 50/50. Most preferably, it is 25/75 to 40/60.

An example of an acrylic core shell polymer comprises 70 weight parts 55/45 (w/w) styrene/ 2-ethylhexyl acrylate copolymer having M_W of 100'000 g/mol and T_g of about 15 °C as acrylic polymer, and 30 weight parts 65/35 (w/w) styrene/acrylic acid, ammonium salt copolymer having M_W of 8'000 g/mol and T_g of about 105 °C as stabilizing polymer.

The acrylic core shell polymer can be prepared by polymerizing the monomers forming the acrylic polymer in the presence of the stabilizing polymer and a suitable initiator. Preferably, the stabilizing polymer and part of the initiator is charged to a vessel and the remaining initiator and the monomers are fed to the vessel. Usually, the polymerization is performed in water as solvent. The initiator can be any suitable initiator such as a peroxide, a persulfate, an azo compound, a redox couple or mixtures thereof. Preferably, the initiator is a persulfate, more preferably, it is ammonium persulfate. Preferably, the molar ratio of initiator or initiators/ monomer or monomers is between 0.0001% and 1%.

The wax can be any kind of suitable wax or wax mixture. Examples of wax are natural wax, chemically modified wax and synthetic wax.

Examples of natural wax are vegetable wax such as carnauba wax or candilla wax, animal wax such as bee wax or wool wax, and mineral wax such as paraffin and ceresin.

An example of a chemically modified wax is hydrated jojoba wax. Examples of synthetic waxes are polyethylene wax and polyethyleneglycol wax.

Preferably, the wax is a natural wax, a synthetic wax or a mixture thereof. A preferred wax is a mixture of paraffin wax and carnauba wax. An aqueous emulsion thereof is commercially available as Aquabead 525E from Micropowders, Inc. (USA). Another preferred wax is a mixture of paraffin and polyethylene. An aqueous emulsion thereof is commercially available as Michem 60233 from Michelman, Inc. (USA).

Preferably, the water vapor barrier also comprises a wax.

The weight ratio of the polymer and the wax can range from 1/99to 99/1, preferably from 50/50 to 95/5, more preferably from 70/30 to 90/10, most preferably from 75/25 to 85/15.

The total amount (dry weight) of the polymer and the wax in water vapor barrier (dry weight) ranges from 50 to 100% by weight based on the weight of the water vapor barrier after drying, preferably from 80 to 100%, more preferably from 90 to 100%, most preferably from 95 to 100%.

The water vapor barrier can comprise 10 to 99% by dry weight of the polymer based on the barrier (dry weight). Preferably, it comprises 30 to 95% by dry weight of the polymer based on the barrier (dry weight), more preferably, 50 to 95%, most preferably 70 to 90%.

The water vapor barrier can comprise 1 to 80% by dry weight of the wax based on the barrier (dry weight). Preferably, it comprises 1 to 60% by dry weight of the polymer based on the barrier (dry weight), more preferably, 5 to 40%, most preferably 10 to 30%.

The coating weight of the water vapor barrier can range from 0.1 to 20 g/m^2 on the corrugated board, preferably from 1 to 10 g/m^2, more preferably from 3 to 7 g/m^2. The values refer to the dry weight of the barrier.

The layer that it is essentially impermeable to oil (oil barrier) can be any layer comprising at least one polymer, which layer is essentially impermeable to oil.

Preferably the polymer of the oil barrier is also an acrylic polymer and everything said above about the acrylic polymer of the water vapor barrier is also valid for the acrylic polymer of the oil barrier. Preferably, the acrylic polymers of the water vapor barrier and of the oil barrier are identical.

The amount (dry weight) of the polymer in oil barrier (dry weight) ranges from 50 to 100% by weight based on the weight of the oil barrier after drying, preferably from 80 to 100%, more preferably from 90 to 100%, most preferably from 95 to 100%.

The coating weight of the oil barrier can range from 0.1 to 20 g/m^2 corrugated board, preferably from 1 to 10 g/m^2, more preferably from 3 to 7 g/m^2. The values refer to the dry weight of the barrier.

Any corrugated board can be used to prepare the coated corrugated board of the present invention. Corrugated board is well-known in the art and commercially available. A single wall corrugated board consists of an outer liner, an inner liner and a fluting. The latter determines the height of the single wall corrugated board. Different types of fluting exist, which, in the order of decreasing height, are named A, B, C, E, F, G, N and O flutes. For example, A fluting have a flute height of 4.5 to 4.7 mm and 105 to 125 flutes per metre wheras E fluting have a flute height of 1.1 to 1.2 mm and 290 to 320 flutes per metre. A, B, C and E flutings are usually used for cases and trays. E, F and G flutings are usually used for cartons. Besides single wall corrugated board, there are also double and triple wall corrugated boards available. Mixture of A, B, C and F flutings are usually used for double and triple wall corrugated board. Preferably, the corrugated board is a single wall corrugated board.

The coated corrugated board of the present invention can be obtained by coating corrugated board with coating compositions that form the water vapor barrier, respectively, the oil barrier.

Thus, a process for preparing the coated corrugated board by coating corrugated board on one exterior side (outer liner) with a coating composition that forms the water vapor barrier and on the other exterior side (outer liner) with a second coating compositions that form the oil barrier is also part of the invention. The coating compositions that form the water vapor barrier comprise the polymer, optionally the wax and a solvent. The coating compositions that form the oil barrier comprise the polymer and a solvent. The solvent can be any solvent. Preferably, the solvent is water, an organic solvent or mixtures of water and organic solvents. Preferably, it is water or a mixture of water and an organic solvent. More preferably, it is water.

Examples of organic solvents are C_{1-4}-alkanols, C_{2-4}-polyols, C_{3-6}-ketones, C_{4-6}-ethers, C_{2-3}-nitriles, nitromethane, dimethylsulfoxide, dimethylformamide, dimethylacetamide, *N*-methyl pyrolidone and sulfolane, whereby C_{1-4}-alkanols and C_{2-4}-polyols may be substituted with C_{1-4}-alkoxy. Examples of C_{1-4}-alkanols are methanol, ethanol, propanol,

isopropanol or butanol, isobutanol, *sec*-butanol and *tert*-butanol. Examples of a C_{1-4}-alkoxy-derivatives thereof are 2-ethoxyethanol and 1-methoxy-2-propanol. Examples of C_{2-4}-polyols are glycol and glycerol. Examples of C_{3-6}-ketones are acetone and methyl ethyl ketone. Examples of C_{4-6}-ethers are dimethoxyethane, diisopropylethyl and tetrahydrofurane. An example of a C_{2-3}-nitrile is acetonitrile.

The coating compositions that form the water vapor barrier, respectively, the oil barrier can be a solution, emulsion or dispersion. Preferably, the coating compositions are aqueous emulsions.

Preferably, the coating composition forming the water vapor barrier comprises 1 to 80% by weight polymer based on the weight of the coating composition. More preferably, it comprises 10 to 60%, most preferably 20 to 40% by weight polymer.

Preferably, the coating composition forming the water vapor barrier comprises 1 to 50% by weight wax based on the weight of the coating composition. More preferably, it comprises 1 to 40%, most preferably 5 to 15% by weight wax.

Preferably, the coating composition forming the water vapor barrier comprises 10 to 95% by weight solvent based on the weight of the coating composition. More preferably, it comprises 20 to 70%, most preferably 30 to 50% by weight solvent.

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Preferably, the coating composition forming the oil barrier comprises 1 to 95% by weight polymer based on the weight of the coating composition. More preferably, it comprises 30 to 80%, most preferably 50 to 70% by weight polymer.

Preferably, the coating composition forming the oil barrier comprises 10 to 95% by weight solvent based on the weight of the coating composition. More preferably, it comprises 20 to 80%, most preferably 30 to 70% by weight solvent.

Preferably, the coating compositions forming the water vapor barrier, respectively, the oil barrier are applied in form of aqueous emulsions having a solid content in the range of 5 to 80% by weight based on the weight of the coating composition, more preferably in the range of from 20 to 60%, most preferably in the range of from 30 to 50%.

The coating compositions forming the water vapor barrier, respectively, the oil barrier can be applied by coating applications known in the art such as a bar coater application, rotation application, spray application, curtain application, dip application, air application, knife application, blade application, roll application or film press. Bar coating is preferred. After application of the coating compositions forming the water vapour barrier, respectively, the oil barrier, usually, in form of an aqueous emulsion, the coating compositions are dried to form the barriers. Drying can be accomplished by either contact or contact-less drying or through a combination of several methods. Examples of contact-less drying are forced hot air drier or Infra-Red drier, whereas examples of contact drying are Drum Drier. Whether the coating composition forming the oil barrier or the coating composition forming the water vapor barrier is applied first or second has no influence on the success of the invention.

The inventive corrugated board can be used to manufacture corrugated board boxes, usually by cutting and folding in appropriate ways.

Therefore also part of the invention are corrugated board boxes obtainable from corrugated board of the present invention, characterized in that the water vapor barrier is on the ouside of the box and the oil barrier is on the inside of the box.

The corrugated board boxes can have all kind of dimensions, for example the boxes can be approximately 40 cm long x 30 cm wide x 25 cm high.

Also part of the invention is the use of the corrugated board boxes of the present invention for handling and storing goods under conditions of high relative humidity.

High relative humidity can be 60 to 99% relative humidity, preferably 70 to 95% relative humidity, more preferably 75 to 90% relative humidity.

Any kind of goods can be used. Preferably, food is used.

One embodiment of this use is the use of the corrugated board boxes of the present invention for handling and storing goods under chiller room conditions.

Chiller rooms are rooms have a temperature well below room temperature, but not freezing, and a relative high humidity. The temperature can be in the range of from 0.1 to 10 °C, preferably, from 1 to 6 °C, more preferably, from 2 to 4 °C.

It is especially preferred to store food under chiller room conditions. In particular food containing a considerable amount of fat, especially fat that is rather soft or liquid, i.e. does not harden, under the conditions of the chiller room, for example unsaturated fatty acid esters. A preferred kind of food to be stored under chiller room conditions are potato fries containing unhardened palm oil.

Another embodiment of this use is the use of the corrugated board boxes of the present invention for handling and storing goods under tropical conditions.

Tropical conditions refer to temperatures well above 30 °C and a high relative humidity. The temperature can be in the range of from 30 to 60 °C, preferably, from 30 to 45°C, more preferably, from 35 to 45 °C.

Also part of the invention is the use of a layer that is impermeable to water vapor (water vapor barrier) and a layer that is impermeable to oil (oil barrier) for improving the strength and the tape adhesion of corrugated board and corrugated board boxes.

Another part of the invention is a method for improving strength and tape adhesion of corrugated board boxes, characterized in using corrugated board, which is coated on one exterior side (outer liner) with a layer that is impermeable to water vapor (water vapor barrier) and on the other exterior side (outer liner) with a layer that is impermeable to oil (oil barrier), wherein the water vapor barrier is on the outside of the box and the oil barrier is on the inside of the box.

The coated corrugated board boxes of the present invention have the advantage that they show improved strength and good adhesion to adhesive tape when stored under conditions of high relative humidity. In addition, the coated corrugated board is recyclable and repulpable. Further, if an acrylic core shell polymer is used as polymer, the coated corrugated board shows an improved processability during coating, as the barrier coating compositions dry especially quickly and as a consequence the corrugated board has no

tendency to be glued together when rolled up after treatment with the barrier coating compositions.

Examples

Example 1: Preparation of water-based barrier coating (WBBC) composition A

Butyl acetate (250 g) is charged to a reactor and heated to reflux (125 °C). *tert*-Butyl perbenzoate (7.8 g) is added to the reactor. A monomer feed consisting of styrene (162.5 g) and glacial acrylic acid (87.5 g) is prepared. An initiator feed consisting of *tert*-butyl-perbenzoate (23.4 g) is prepared. The monomer feed is added to the reactor within 5 hours and the initiator feed is added to the reactor within 5.5 hours. Once the feeds are completed, the reaction mixture is held for a further 1 hour at 125 °C. A mixture of 20% by weight aqueous ammonia (100 g) and water (700 g) is added to the reactor whilst distilling off butyl acetate. The distillate is split and the water returned to the reactor and the butyl acetate to the receiver. The temperature of the reaction mixture falls to 93 °C during distillation and rises to 100 °C when all the butyl acetate has been removed. When distillation is complete, the reaction mixture is cooled to below 40 °C, the obtained solution of 65/35 (w/w) styrene/acrylic acid, ammonium salt is adjusted to 25% by weight solid content and pH 9.0.

The 25% by weight aqueous solution of styrene/acrylic acid, ammonium salt copolymer (576 g) and water (71 g) is charged to a reactor, heated to 85 °C and degassed with nitrogen for 30 minutes. Ammonium persulfate (0.5 g) is added. A monomer feed consisting of styrene (184.8 g) and 2-ethylhexyl acrylate (151.2 g) is prepared. An initiator feed consisting of ammonium persulfate (1.5 g) and water (15.0 g) is prepared. The monomer feed is added to the reactor within 3 hours and the initiator feed is added to the reactor within 4 hours. The temperature of the reaction mixture is kept at 85 °C during polymerisation. Once the feeds are completed, the contents is held for a further 1 hour at 85 °C before being cooled to below 40 °C and Acticide® LG, a biocide containing chlorinated and non-chlorinated methyl isothiazolones, (0.9 g) is added.

The obtained WBBC composition A is an aqueous emulsion of of a core shell polymer consisting of 70 weight parts 55/45 (w/w) styrene/2-ethylhexyl acrylate copolymer having M_W of 100'000 g/mol and T_g of about 15 °C and 30 weight parts 65/35 (w/w) styrene/acrylic acid, ammonium salt copolymer having M_W of 8'000 g/mol and T_g of about 105 °C. The aqueous

emulsion has a solid content of about 46% (w/w), a pH of 8.5 and a viscosity at 25 °C (Brookfield 20 rpm) of 700 mPa x s.

Example 2: Preparation of water-based barrier coating (WBBC) composition B

WBBC composition A and "Aquabead 525E", which is commercially available by Micro Powders Inc (USA) and which is an aqueous emulsion of a mixture of refined paraffin wax (CAS No. 63231-60-7) and Carnauba wax (CAS No. 8015-86-9), are mixed under light agitation to obtain WBBC composition B, which is an aqueous emulsion of a 80/20 (w/w) mixture of the core shell polymer of WBBC composition A and the wax of "Aquabead 525E". WBBC composition B and which has a solids content of approximately 40% (w/w), a pH of 8.5 to 9.5 and a viscosity at 25 °C (Brookfield 20 rpm) of 50 to 300 mPa x s.

Example 3: Coating of corrugated boxes with WBBC compositions A and B

A piece of single wall corrugated board (C-board, 4mm thickness, 130 flutes/1m, A5) is first coated on one exterior side (outer liner), which simulates the inside of a box, with WBBC composition A obtained as described in example 1, diluted to 30% solids, using a bar coater and dried using a contact-less laboratory dryer (infrared and air at 130 °C) to yield a coating having a coat weight of 5 g/m^2, and then coated on the other exterior side (outer liner), which simulates the outside of a box, with WBBC composition B obtained as described in example 2 using the same bar coater and dried using also a laboratory dryer to yield a coating having a coat weight of 5 g/m^2.

Example 4: Treating the coated corrugated boards under chiller room conditions

The one exterior side simulating the inside of a box and the edges of the pieces of corrugated board obtained in example 3 are sealed with ParaFilm to prevent moisture entering the board via the simulated inside of the box or the edges. The so-sealed pieces of coated corrugated boards are conditioned at 4°C at 80% relative humidity for 24 h.

Flat crush test (FCT) and edge chrush test (ECT)

A "flat crush test" and a "edge crush test" are performed on the coated corrugated board before and after treatment under chiller room conditions. As comparison, uncoated corrugated board is used. The results for each board are the average of three measurements. The tests are performed with a Lorentzen & Wettre (L&W) Crush tester.

The FCT measures the resistance of the flutes to a crushing force applied perpendicular to the surface of the board. A test piece of corrugated board is cut with the L&W Circular Cutter into an area of 100 cm^2. The test piece of the corrugated board is placed between the plates of the L&W crush tester and the test piece is subjected to increasing force applied perpendicular to the surface of the board until the fluting breaks.

The following Table shows the results of the FCT:

Corrugated board	Grammage [g/m^2]	FCT [kN] unconditioned	FCT [kN] conditioned	Strength maintained [%]
example 3	472	2.83	2.21	78
uncoated	462	2.67	1.91	72

Table 1: FCT results before and after conditioning under chiller room conditions.

The test results show that the corrugated board obtained in example 3 shows higher FCT values before as well as after conditioning under chiller room conditions compared to uncoated corrugated board. In addition, the strength maintained is also higher for the coated corrugated board.

The ECT measures the edgewise compression strength parallel to the flutes. The test piece is cut with L&W edge crush test cutter into an area of 5 cm^2 and the short column shape is cut with an L&W Circular neck down cutter. Test piece shape is decribed in J.W. Koning, “A Short Column Crush Test of Corrugated Fibreboard” TAPPI Journal, 1964, 47(3), 134-137. The test piece is placed between the two plates so that the fluting is parallell to the plates. The cut sample of corrugated board is subjected to increasing force until it breaks.

The following table shows the results of the ECT:

Corrugated board	Grammage [g/m^2]	ECT [N] unconditioned	ECT [N] conditioned	Strength maintained [%]
example 3	472	141	113	80
uncoated	462	108	88	81

Table 2: ECT results before and after conditioning under chiller room conditions.

The test results show that the corrugated board obtained in example 3 shows higher ECT values before as well as after conditioning under chiller room conditions compared to uncoated corrugated board. The strength maintained is about the same for the uncoated and the coated corrugated board.

Tape adhesion test ("Y peel test")

The corrugated board obtained in example 3 is cut into 25 mm wide and 11 cm long test samples. A tape (3M^{TM} polyethylene film tape 483) the same size as the board is sealed to the top end (25 mm) of the corrugated board and attached to the board so that half of the tape is sticking to the board and the other half of the tape is not sticking to the board (the board and the tape form a "Y"). The tape is once attached to the exterior side, which is coated with WBBC composition B (simulating the outside of a box), and once to the interior side, which is coated with WBBC composition A (simulating the inside of a box). The tape is also attached to an uncoated corrugated board for comparison.

The tape is attached to the board with a Cobb roll (10 kg) to insure the same amount of pressure is put on the joint. The two legs of the "Y" are mounted to the bottom clamps of a Zwick Materials Testing machine (Model 2006) and the sealed joint to the top clamp. The peel force is adjusted to 12.5 mm/min. During the test the top clamp is moved upwards and the force to pull apart the samples registered under the deformation of 3 mm. With the "Y peel test" a "load – deformation" curve is produced. The total work is calculated from the curve and describes the force needed to pull apart the samples. The "Y peel test" is also described in J. Tryding *et al*, VVD 2003, Verabeitungsmaschinen und Verpackungstechnik, Dresden, 03 bis 04 April 2003.

The following table shows the results of the tape adhesion test:

Corrugated board	Total work [J/m]	Standard deviation
uncoated	0.56	0.09
example 3, WBBC A coated side	0.88	0.21
example 3, WBBC B coated side	0.65	0.09

Table 3. Results of the tape adhesion test.

Thus the coating with WBBC composition A and B improves the peel force between the tape and the surface of the corrugated board compared to uncoated corrugated board.

Example 5: Coating of corrugated boxes with WBBC compositions A and B

Corrugated boards are coated as described in example 3 except that coatings having a coat weight of 6 g/m^2 are obtained.

Example 6: Treating the coated corrugated boards under tropical conditions

The one exterior side simulating the inside of a box and the edges of the pieces of corrugated board obtained in example 5 are sealed with ParaFilm to prevent moisture entering the board via the simulated inside of the box or the edges. The so-sealed pieces of coated corrugated boards are conditioned at 40°C at 80% relative humidity for 24 h.

Flat crush test (FCT) and edge chrush test (ECT)

A “flat crush test” and a “edge crush test” are performed on the coated corrugated board before and after treatment under tropical conditions. As comparison, uncoated corrugated board is used. The results for each board are the average of three measurements. The test conditions are as described in example 4.

The following Table shows the results of the FCT:

Corrugated board	Grammage [g/m^2]	FCT [kN] unconditioned	FCT [kN] conditioned	Strength maintained [%]
example 5	473	2.86	2.53	87
uncoated	461	2.72	2.11	78

Table 4: FCT results before and after conditioning under tropical conditions.

The test results show that the corrugated board obtained in example 5 shows higher FCT values before as well as after conditioning under tropical conditions compared to uncoated corrugated board. In addition, the strength maintained is also higher for the coated corrugated board.

The following table shows the results of the ECT:

Corrugated board	Grammage [g/m^2]	ECT [N] unconditioned	ECT [N] conditioned	Strength maintained [%]
example 5	473	132	95	72
uncoated	462	117	68	58

Table 5: ECT results before and after conditioning under tropical conditions.

The test results show that the corrugated board obtained in example 5 shows higher ECT values before as well as after conditioning under tropical conditions compared to uncoated corrugated board. In addition, the strength maintained is also higher for the coated corrugated board.

Claims

1. Corrugated board wherein one exterior side is coated with a water vapor barrier, a layer that is essentially impermeable to water, and the second exterior side is coated with an oil barrier, a layer that is essentially impermeable to oil.

2. The corrugated board of claim 1 wherein the water vapor barrier comprises at least one polymer and a wax.

3. The corrugated board of claim 1 or claim 2 wherein the oil barrier comprises at least one polymer.

4. A process for preparing the coated corrugated board of any of claims 1 to 3 by coating corrugated board on one exterior side with a coating composition forming the water vapor barrier and on the other exterior side with a second coating composition forming the oil barrier.

5. A corrugated board box obtainable from the corrugated board of any of claims 1 to 3, wherein the water vapor barrier is on the outside of the box and the oil barrier is on the inside of the box.

6. Use of the corrugated board boxes of claim 5 for handling and storing goods under conditions of high relative humidity.

7. The use of claim 6 for handling and storing goods under chiller room conditions.

8. The use of claim 6 for handling and storing goods under tropical conditions.

9. Use of a water vapor barrier, a layer that is essentially impermeable to water vapor, and an oil barrier, a layer that is essentially impermeable to oil, for improving the strength and the tape adhesion of corrugated board and corrugated board boxes.

10. Method for improving strength and tape adhesion of corrugated board boxes, wherein corrugated board is used, which is coated on one exterior side with a water vapor barrier, a

layer that is essentially impermeable to water vapor, and on the other exterior side with an oil barrier, a layer that is essentially impermeable to oil, and wherein the water vapor barrier is on the outside of the box and the oil barrier is on the inside of the box.

5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/054031

A. CLASSIFICATION OF SUBJECT MATTER
INV. D21H27/40 D21H19/18 B65D65/40

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)
D21H B65D

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, 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	WO 99/45059 A (GROUPE RECH I D INC [CA]) 10 September 1999 (1999-09-10) claims 1,15-22; figure 1 page 1, line 4 - line 15 page 4, line 15 - line 17 page 12, line 1 - line 15	1-10
X	WO 2004/046463 A2 (INT PAPER CO [US]) 3 June 2004 (2004-06-03) claims; figure 1 page 10, line 20 - page 12, line 18 page 1, line 5 - page 2, line 20	1-10
X	WO 02/064369 A (KORSNAES AB [SE]; LARSSON NILS-AAKE [SE]; JOHANSSON TORD [SE]) 22 August 2002 (2002-08-22) page 3, line 12 - line 18; claims	1-10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 June 2007	22/06/2007

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/EP2007/054031

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