

A barrier layerTechnical Field

The present invention relates to a barrier layer, particularly a barrier layer for use in a
5 barrier laminate.

Background

Many products are sensitive to oxygen and/or water vapour. These products can
degrade rapidly in ambient atmospheric conditions if not protected properly. For
example, food products and pharmaceutical products may turn rancid due to oxidation
10 and bacteria germination. Electronic components or metal parts exposed to ambient
conditions may also start to rust which may hinder their functioning. For this reason,
such sensitive products are packaged in special packaging material to limit contact to
oxygen and water vapour.

However, many of the packagings currently in use comprise multiple layers of different
15 materials to provide the necessary oxygen barrier and water vapour barrier. This
reduces the recyclability of the packaging.

Existing mono-material packaging, while providing oxygen barrier at low relative
humidity, are unable to provide sufficient water vapour barrier. Accordingly, an
additional layer or coating may be required to act as a water vapour barrier, thereby
20 increasing production time and cost.

Thus, there is a need for an improved barrier layer, particularly for packaging products
sensitive to oxygen and water vapour.

Summary of the invention

The present invention seeks to address these problems, and/or provides a barrier layer
25 suitable for providing a barrier to oxygen and water vapour.

According to a first aspect, the present invention provides a water-based barrier layer
comprising an inorganic filler dispersed in a hydrophobic polymeric matrix, the
polymeric matrix comprising a carboxylic acid derivative copolymer, wherein the barrier
layer is a single layer for blocking gas and moisture simultaneously.

In particular, the barrier layer may have an oxygen transmission rate of $\leq 70 \text{ cm}^3/\text{m}^2$ day at 23°C, 50% relative humidity and a water vapour transmission rate of $\leq 3 \text{ g}/\text{m}^2$ day at 38°C, 90% relative humidity. The barrier layer according to the present invention may be hydrophobic.

- 5 The polymeric matrix may be any suitable polymeric matrix. In particular, the carboxylic acid derivative copolymer comprised in the polymeric matrix may comprise at least one carboxylic acid or carboxylic acid ester. For example, the carboxylic acid derivative copolymer may be, but not limited to, an acrylic acid copolymer, citric acid copolymer, sulfonic acid copolymer or sulfinic acid copolymer.
- 10 According to a particular aspect, the polymeric matrix may comprise a carboxylic acid derivative copolymer, in which the carboxylic acid derivative copolymer may be formed from at least one hydrophobic monomer and at least one hydrophilic monomer.

According to a particular aspect, the carboxylic acid derivative copolymer may be a copolymer of a carboxylic acid derivative and one or more polymers selected from:

15 polystyrene, polyethylene (PE), polypropylene (PP), polyvinyl alcohol (PVA), ethylene vinyl acetate (EVA), polycarbonate, and polyethylene terephthalate (PET).

The inorganic filler comprised in the barrier layer may comprise any suitable inorganic filler. For example, the inorganic filler may comprise, but is not limited to, at least one of: alkali metals, aluminium, silicon, tin, titanium, zinc, zirconium, and iron. In particular,

20 the inorganic filler may comprise at least one: oxide, hydroxide, nitride, halide, carbide of alkali metals, aluminium, silicon, tin, titanium, zinc, zirconium, and iron. According to a particular aspect, the inorganic filler may comprise a silicate.

The barrier layer may comprise any suitable amount of inorganic filler. For example, the barrier layer may comprise 1-50 wt % inorganic filler based on the total weight of

25 the barrier layer.

The barrier layer may comprise any suitable amount carboxylic acid polymer derivative. For example, the barrier layer may comprise 50-99 wt % carboxylic acid derivative copolymer based on the total weight of the barrier layer.

According to a particular aspect, the barrier layer may have a solid content of 5-80 wt

30 % based on the total weight of a wet barrier layer.

The barrier layer may have a suitable viscosity. In particular, the barrier layer may have a viscosity of ≤ 500 mPa.s.

The barrier layer may have a suitable thickness. For example, the barrier layer may have a thickness of 0.5-20.0 μm .

- 5 According to a second aspect, the present invention provides a barrier laminate comprising a substrate and a barrier layer according to the first aspect, wherein the barrier layer may be formed directly on the substrate.

The substrate may be any suitable substrate. For example, the substrate may be a polar or non-polar substrate. In particular, the substrate may be, but not limited to, one
10 or more of: paper, plastic and metal.

According to a particular aspect, the substrate may be a non-polar polymeric substrate.

Brief Description of the Drawings

In order that the invention may be fully understood and readily put into practical effect there shall now be described by way of non-limitative example only exemplary
15 embodiments, the description being with reference to the accompanying illustrative drawings. In the drawings:

Figure 1 shows a schematic representation of a cross-section of a paper packaging comprising a barrier layer according to one embodiment of the present invention;

Figure 2 shows a schematic representation of a cross-section of a paper packaging
20 comprising a barrier layer according to one embodiment of the present invention;

Figure 3 shows a schematic representation of a cross-section of a paper packaging comprising a barrier layer according to one embodiment of the present invention;

Figure 4 shows a schematic representation of a cross-section of a flexible plastic packaging comprising a barrier layer according to one embodiment of the present
25 invention;

Figure 5 shows a schematic representation of a cross-section of a flexible plastic packaging comprising a barrier layer according to one embodiment of the present invention;

Figure 6 shows a schematic representation of a barrier layer according to one embodiment of the present invention provided on a packaging surface; and

Figure 7 shows a schematic representation of a set-up for measuring the oxygen transmission rate (OTR) and water vapour transmission rate (WVTR) of the barrier layer according to one embodiment of the present invention.

Detailed Description

As explained above, there is a need for an improved barrier layer for packaging particularly for products which are sensitive to oxygen and water vapour.

In general terms, the present invention provides a barrier layer which has high oxygen and water vapour barrier characteristics. The barrier layer may be suitable for use in packaging of oxygen and/or water vapour sensitive products such as, but not limited to, food products, pharmaceutical products, electronic components, and metal components. The barrier layer is advantageous in that additional barrier layers are not required to provide the necessary barrier characteristics. Further, the barrier layer may be used directly on substrates without requiring an additional adhesive layer, thereby reducing amount of material used and reducing processing steps in packaging products.

According to a first aspect, the present invention provides a water-based barrier layer comprising an inorganic filler dispersed in a hydrophobic polymeric matrix, the polymeric matrix comprising a carboxylic acid derivative copolymer, wherein the barrier layer is a single layer for blocking gas and moisture simultaneously.

For the purposes of the present invention, water-based barrier layer refers to a barrier layer formed from aqueous solvents. In particular, the water-based barrier layer does not comprise any significant amount of organic solvents and is primarily formed from aqueous solvents.

The barrier layer may provide an effective barrier to oxygen and water vapour, thereby reducing the amount of oxygen and water vapour transmitting through the barrier layer. According to a particular aspect, the barrier layer may have an oxygen transmission rate of $\leq 70 \text{ cm}^3/\text{m}^2 \text{ day}$ at 23°C , 50% relative humidity. For example, the oxygen transmission rate at 23°C , 50% relative humidity may be $10\text{-}70 \text{ cm}^3/\text{m}^2 \text{ day}$, $20\text{-}68$

cm³/m² day, 25-65 cm³/m² day, 30-60 cm³/m² day, 35-55 cm³/m² day, 40-50 cm³/m² day. In particular, the oxygen transmission rate may be 60-70 cm³/m² day at 23°C, 50% relative humidity.

According to a particular aspect, the barrier layer may have a water vapour transmission rate of ≤ 3 g/m² day at 38°C, 90% relative humidity. For example, the water vapour transmission rate at 38°C, 90% relative humidity may be 0.5-3 g/m² day, 1.0-2.5 g/m² day, 1.5-2.25 g/m² day, 1.75-2.0 g/m² day. In particular, the water vapour transmission rate may be 1.5-2.5 g/m² day at 38°C, 90% relative humidity.

The inorganic filler comprised in the barrier layer may be any suitable inorganic filler. For example, the inorganic filler may comprise, but is not limited to, at least one of: alkali metals, aluminium, silicon, tin, titanium, zinc, zirconium, and iron. In particular, the inorganic filler may be in the form of at least one of: oxide, hydroxide, nitride, halide, carbide of the alkali metal, aluminium, silicon, tin, titanium, zinc, zirconium, and iron. For example, the inorganic filler may be, but not limited to, aluminium oxide, bayerite, boehmite, gibbsite, silicon oxide, diaspore, attapulgite, bentonite, hectorite, hydrotalcite, kaolinite, mica, montmorillonite, vermiculite, or a mixture thereof. According to a particular aspect, the inorganic filler may comprise a silicate.

The inorganic filler may be surface modified to improve its dispersibility. The surface modification may be any suitable surface modification. For example, the surface of the inorganic filler may be modified by a polymer.

The barrier layer may comprise a suitable amount of inorganic filler. For example, the barrier layer may comprise 1-50 wt % inorganic filler based on the total weight of the barrier layer. The total weight of the barrier layer may be based on the dry weight of the barrier layer. In particular, the barrier layer may comprise 2-40 wt %, 3-35 wt %, 5-30 wt %, 10-25 wt %, 15-20 wt % inorganic filler. Even more in particular, the barrier layer may comprise 5-17 wt % inorganic filler.

The polymeric matrix may be any suitable polymeric matrix. In particular, the polymeric matrix may be hydrophobic.

According to a particular aspect, the polymeric matrix may comprise a carboxylic acid derivative copolymer. For the purposes of the present invention, a carboxylic acid

derivative copolymer may be defined as a copolymer comprising at least one monomer of a carboxylic acid derivative. For example, the carboxylic acid derivative may be at least one of, but not limited to: carboxylic acid, carboxylate, carboxylic acid ester, amide, thioester, acyl phosphate, trialkylacetic acid, or trialkyl phosphate. In particular, the carboxylic acid derivative may be at least one of: carboxylic acid or carboxylic acid ester.

The carboxylic acid derivative copolymer may be formed from at least one monomer which may be hydrophilic and at least one monomer which may be hydrophobic.

According to a particular aspect, the carboxylic acid derivative copolymer may comprise at least two carboxylic acids polymerised to form a copolymer; at least two carboxylic acid esters polymerised to form a copolymer; a carboxylic acid and a carboxylic acid ester polymerised to form a copolymer; at least one carboxylic acid and a polymer to form a copolymer; or at least one carboxylic acid ester and a polymer to form a copolymer.

According to a particular aspect, the carboxylic acid derivative copolymer comprised in the polymeric matrix may be formed from at least one carboxylic acid monomer or carboxylic acid ester monomer. For example, the carboxylic acid derivative copolymer may be, but not limited to, an acrylic acid copolymer, citric acid copolymer, sulfonic acid copolymer or sulfinic acid copolymer.

According to a particular aspect, the carboxylic acid derivative copolymer may be formed from at least one carboxylic acid derivative monomer and at least one polymer. The polymer may be any suitable polymer. For example, the polymer may be an oligomer. In particular, the polymer may be any polymer which can solubilise. Even more in particular, the polymer may be at least, but not limited to: polystyrene, polyethylene (PE), polypropylene (PP), polyvinyl alcohol (PVA), ethylene vinyl acetate (EVA), polycarbonate, polyethylene terephthalate (PET).

The barrier layer may comprise any suitable amount carboxylic acid derivative copolymer. For example, the barrier layer may comprise 50-99 wt % carboxylic acid derivative copolymer based on the total weight of the barrier layer. The total weight of the barrier layer may be based on the dry weight of the barrier layer. In particular, the barrier layer may comprise 60-98 wt %, 65-95 wt %, 70-90 wt %, 75-85 wt %, 80-82 wt

% inorganic filler. Even more in particular, the barrier layer may comprise 83-95 wt % carboxylic acid derivative copolymer.

The barrier layer may further comprise additives. The additives may be any suitable additives for the purposes of the present invention. For example, the additive may
5 comprise, but is not limited to, wetting agent, anti-foaming agent, adhesion promoter, water soluble initiator, surfactant, emulsifying agent, coalescing agent, or a combination thereof.

According to a particular aspect, the barrier layer may have a solid content of 5-80 wt % based on the total weight of a wet barrier layer. For the purposes of the present
10 invention, reference to a wet barrier layer comprises a barrier layer mixture which has not been dried to form the barrier layer. In particular, the solid content may be 10-50 wt %, 15-45 wt %, 20-42 wt %, 25-40 wt %, 28-38 wt %, 30-36 wt %, 32-35 wt % based on the total weight of a wet barrier layer. Even more in particular, the solid content may be 25-40 wt % based on the total weight of a wet barrier layer.

15 The barrier layer may have a suitable viscosity. In particular, the barrier layer may have a viscosity of ≤ 500 mPa.s. The viscosity of the barrier layer refers to the viscosity as measured at a suitable solid content. For example, the viscosity may be measured for a barrier layer comprising a solid content of ≤ 50 wt %, particularly 5-50 wt %. The advantage of a lower viscosity is that the thickness of the barrier layer may be reduced
20 while providing adequate oxygen barrier and water vapour barrier.

The barrier layer may have a suitable thickness. For example, the barrier layer may have a thickness of 0.5-20.0 μm . In particular, the barrier layer may have a thickness of 0.5-18.0 μm , 1.0-15.0 μm , 2.0-12.0 μm , 5.0-10.0 μm , 7.0-9.0 μm . Even more in particular, the barrier layer may have a thickness of 0.5-8.0 μm .

25 The barrier layer may be a single layer. In particular, additional layers may not be necessary to reduce the water vapour transmission and oxygen transmission through the barrier layer. Since the barrier layer does not comprise additional layers of different polymers, a packaging comprising the barrier layer may be more easily recycled, making the packaging more environmentally friendly.

The barrier layer according to the present invention may be hydrophobic. In this way, the polymer matrix comprised in the barrier layer minimizes moisture absorption and retention, thereby providing an effective barrier against water vapour transmission. In particular, the inorganic filler may be hydrophilic and therefore be able to block
5 transmission of gases, such as oxygen through the barrier layer. When the inorganic filler is dispersed in the carboxylic acid derivative copolymer, the inorganic filler may bind to the hydrophilic monomer component of the carboxylic acid derivative copolymer, as well as to the hydrophobic monomer component of the carboxylic acid derivative copolymer. In this way, the inorganic filler becomes hydrophobic, and
10 therefore provides a water vapour barrier in addition to the existing oxygen barrier. Further, the inorganic filler and the carboxylic acid derivative copolymer interlink more effectively when the barrier mixture is dried to form the barrier layer to create tortuous paths and no-through paths for the diffusion of low molecular weight compounds such as oxygen and water vapour.

15 As a comparison, prior art barrier layers comprise hydrophobic additives in a hydrophilic polymer matrix. However, the hydrophobic additive may migrate to the surface of the polymer matrix and may disperse over time. While the hydrophilic polymer matrix would therefore attract moisture and enable moisture to pass through the polymer matrix. The hydrophobic additive merely acts as a water repellent on the
20 surface of the polymer matrix and does not block the moisture. In contrast, in the hydrophobic barrier layer of the present invention, the inorganic filler dispersed in the polymer matrix and forming interlinks create an effective barrier for minimising oxygen as well as water vapour transmission.

The barrier layer may be formed by any suitable method. For example, the barrier layer
25 may be formed by: mixing the inorganic filler and the carboxylic acid derivative copolymer in a suitable solvent to form a mixture; and drying the mixture.

The mixing may be by any suitable means. For example, the mixing may be in a reactor. The mixing may comprise mixing a suitable amount of inorganic filler and a suitable amount of carboxylic acid derivative copolymer. In particular, the amount of
30 inorganic filler and the amount of carboxylic acid derivative copolymer may be as described above.

The mixing may further comprise mixing the inorganic filler and the carboxylic acid derivative copolymer with additives. The additives may be any suitable additives. For example, the additives may comprise, but not limited to, wetting agent, anti-foaming agent, surfactant, coalescing agent. In particular, the additive may comprise, but not
5 limited to, isocyanate components, carboxyl reactive cross-linkers, or a combination thereof.

The solvent may be any suitable solvent. In particular, the solvent may be any solvent in which the inorganic filler and the carboxylic acid derivative copolymer can dissolve. For example, the solvent may be water, acetone, ethanol, xylene, or a combination
10 thereof. In particular, the solvent is water.

The method may further comprise preparing the carboxylic acid derivative copolymer prior to the mixing. The preparing may comprise any suitable method of preparing the carboxylic acid derivative copolymer. For example, the preparing may comprise polymerising at least two monomers to form the carboxylic acid derivative copolymer.
15 The polymerising may be under suitable conditions. For example, the preparing may comprise adding an emulsifying agent and/or water-soluble initiators to speed up the preparing. The preparing may further comprise polymerising the monomers at a suitable temperature and for a suitable period of time. For example, the temperature may be about 70°C and the period of time may be about 5-10 hours.

20 The drying may comprise drying the mixture to form the barrier layer. The drying may be under suitable conditions, such as a suitable temperature. For example, the drying may be at a temperature of 30-120°C. In particular, the drying may be at a temperature of 35-110°C, 40-100°C, 45-95°C, 50-90°C, 55-85°C, 60-80°C, 65-75°C, 70-72°C.

According to a second aspect, the present invention provides a barrier laminate
25 comprising a substrate and a barrier layer according to the first aspect, wherein the barrier layer may be formed directly on the substrate.

The substrate may be any suitable substrate. For example, the substrate may be a polar or non-polar substrate. In particular, the substrate may be, but not limited to, one or more of: paper, plastic and metal.

30 According to a particular aspect, the substrate may be a non-polar polymeric substrate.

Some examples of application of the barrier laminate according to the present invention is provided in Figures 1-6. In particular, Figures 1, 2 and 3 illustrate a schematic representation of a cross-section of a paper packaging 100, 200 or 300, as the case may be, in which a barrier layer according to one embodiment of the present invention is utilised. The paper packaging comprises a paper substrate 102 and a barrier layer 104 provided on a surface of the paper substrate 102. The barrier layer 104 may comprise printing 106 on its surface. The packaging may further comprise an overprint varnish 108 to protect the printing 106, particularly to minimise and prevent the damage of the printing 106. The packaging may also comprise an additional sealing layer 110 for sealing the packaging. The sealing layer 110 may comprise a polymer coating.

Figures 4 and 5 provide a schematic representation of a cross-section of a flexible plastic packaging 400 and 500, as the case may be, in which a barrier layer according to one embodiment of the present invention is utilised. The packaging 400 comprises an outer layer 402 and an inner layer 404. The outer layer 402 may comprise printing 106 on its surface. The outer layer 402 and the inner layer 404 may be separated by a barrier layer 104. For example, the outer layer 402 may be formed from, but not limited to, polypropylene or polyethylene, or a combination thereof. For example, the inner layer 404 may comprise, but not limited to, cast polypropylene film or linear low density polyethylene.

The packaging 500 of Figure 5 is similar to packaging 400 of Figure 4, except that packaging 500 may comprise more than one outer layer 402a, 402b, wherein each outer layer 402a is separated from the other outer layer 402b by the barrier layer 104.

Figure 6 provides another example of the application of the barrier layer according to the present invention. In particular, the barrier layer 104 may be provided on a surface of a packaging 602. The packaging 602 may be a plastic packaging such as a plastic container or plastic bottle. The packaging 602 may comprise polyethylene (PE), polypropylene (PP), or polyethylene terephthalate (PET), or a combination thereof. The barrier layer 104 may be coated onto the exterior surface of the packaging 602. For example, the barrier layer 104 may be spray coated onto the exterior surface of the packaging 602.

Having now generally described the invention, the same will be more readily understood through reference to the following embodiment which is provided by way of illustration, and is not intended to be limiting.

Example

5 Example 1

A barrier layer was coated on a paper substrate, particularly on recycled kraft paper acquired using existing single-use paper bags. In particular, the substrate was a general purpose porous recycled kraft paper of 42 gsm (gram square meter). The barrier layer comprised a mixture of silicate emulsion and a carboxylic acid derivative
10 copolymer solution.

The carboxylic acid derivative copolymer solution was produced by emulsion polymerisation process. In particular, methyl 2-methylprop-2-enoate monomer and a butyl prop-2-enoate monomer were mixed in water in a reactor, with acrylic acid and ammonium nonylphenol ether sulfate. The weight ratio of methyl 2-methylprop-2-
15 enoate monomer to butyl prop-2-enoate monomer was 2:4. The weight ratio of the total carboxylic acid ester monomer to water in the reactor was 3:2. Ammonium persulfate and water was mixed in a secondary feed. The weight ratio of ammonium persulfate to water was 1:25. The weight ratio of acrylic acid, ammonium nonylphenol ether sulfate and ammonium persulfate to the total carboxylic acid ester monomer was 1:100, 1:67
20 and 1:335, respectively. Polymerisation was complete after about 6 hours at elevated temperature of 70°C.

After the polymerisation, di(propylene glycol) butyl ether was added. The weight ratio of di(propylene glycol) butyl ether to the total carboxylic ester monomer was 1:13.

Separately, sodium phyllosilicate mineral containing more than 85% montmorillonite in
25 powder form was dispersed in water as an emulsion. The weight ratio of the phyllosilicate to water was 1:16.

Then the phyllosilicate emulsion was mixed with the carboxylic acid derivative copolymer solution together with Carbowet 109 (Evonik) and BYK-014 (BYK) to form the barrier layer. The weight ratio of the phyllosilicate to carboxylic acid derivative
30 copolymer was 1:8. The weight ratio of Carbowet 109 (Evonik) and BYK-014 (BYK) to

the entire barrier layer solution was 1:300 and 1:300, respectively. 3 gsm of dry weight of the barrier layer was coated onto one side of the substrate as shown in Figure 7 using the gravure application method.

The kraft paper coated with the barrier layer was then subjected to an oxygen permeation tester (Illinois model 8001L) having Oxygen Transmission Rate (OTR) measurement range of 0.005 to 432,000 cm³/m² day at 23°C, 30% to 90% relative humidity (RH) using ASTM 3985-17 (comparable to ISO 15105-2).

The water vapour permeation tester was Lyssy L80-5000 with Water Vapour Transmission Rate (WVTR) measurement range of 0.03 to 10,000 gm/m².day, 38°C, 90% RH using ISO 15106-1 (comparable to ASTM E 398). The schematic representation of the set up for measuring the OTR and WVTR of the barrier layer is as shown in Figure 7.

The OTR and WVTR measurements obtained are as shown in Table 1.

Material	OTR (cm ³ /m ² day) at 23°C and 50% RH	WVTR (g/m ² day) at 38°C and 90% RH
Uncoated kraft paper (191 gsm)	Permeable	No relevant water vapour barrier
Barrier TPA coated kraft paper (42 gsm)	66.4	2.28

Table 1: OTR and WVTR of kraft paper coated on one side with a barrier layer

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It can be seen from the results obtained that the barrier layer greatly increased the barrier performance of both the oxygen and water vapour transmission of the coated paper substrate from permeable to high barrier properties. In particular, the barrier layer had better OTR and WVTR as compared to most polyolefin-based films and comparable OTR and WVTR to that of vacuum metallised polypropylene films.

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Whilst the foregoing description has described exemplary embodiments, it will be understood by those skilled in the technology concerned that many variations may be made without departing from the present invention.

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Claims

1. A water-based barrier layer comprising an inorganic filler dispersed in a hydrophobic polymeric matrix, the polymeric matrix comprising a carboxylic acid derivative copolymer, wherein the barrier layer is a single layer for blocking gas and
5 moisture simultaneously.
2. The barrier layer according to claim 1, wherein the barrier layer has an oxygen transmission rate of $\leq 70 \text{ cm}^3/\text{m}^2 \text{ day}$ at 23°C , 50% relative humidity and a water vapour transmission rate of $\leq 3 \text{ g}/\text{m}^2 \text{ day}$ at 38°C , 90% relative humidity.
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3. The barrier layer according to claim 1 or 2, wherein the carboxylic acid derivative copolymer is formed from at least one hydrophobic monomer and at least one hydrophilic monomer.
- 15 4. The barrier layer according to any preceding claim, wherein the carboxylic acid derivative copolymer comprises at least one carboxylic acid or carboxylic acid ester.
5. The barrier layer according to any preceding claim 1, wherein the carboxylic acid derivative copolymer is a copolymer of a carboxylic acid derivative and one or
20 more polymers selected from: polystyrene, polyethylene (PE), polypropylene (PP), polyvinyl alcohol (PVA), ethylene vinyl acetate (EVA), polycarbonate, and polyethylene terephthalate (PET).
6. The barrier layer according to any preceding claim, wherein the carboxylic acid
25 derivative copolymer is an acrylic acid copolymer, citric acid copolymer, sulfonic acid copolymer, sulfinic acid copolymer.
7. The barrier layer according to any preceding claim, wherein the inorganic filler comprises at least one of: alkali metals, aluminium, silicon, tin, titanium, zinc,
30 zirconium, and iron.

8. The barrier layer according to any preceding claim, wherein the inorganic filler comprises at least one: oxide, hydroxide, nitride, halide, carbide of alkali metals, aluminium, silicon, tin, titanium, zinc, zirconium, and iron.

5 9. The barrier layer according to any preceding claim, wherein the inorganic filler comprises a silicate.

10. The barrier layer according to any preceding claim, wherein the barrier layer comprises 1-50 wt % inorganic filler based on the total weight of the barrier layer.

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11. The barrier layer according to any preceding claim, wherein the barrier layer comprises 50-99 wt % carboxylic acid derivative copolymer based on the total weight of the barrier layer.

15 12. The barrier layer according to any preceding claim, wherein the barrier layer has a solid content of 5-80 wt % based on the total weight of a wet barrier layer.

13. The barrier layer according to any preceding claim, wherein the barrier layer has a viscosity of ≤ 500 mPa.s.

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14. The barrier layer according to any preceding claim, wherein the barrier layer is hydrophobic.

15. The barrier layer according to any preceding claim, wherein the barrier layer
25 has a thickness of 0.5-20.0 μm .

16. A barrier laminate comprising a substrate and a barrier layer according to any of claims 1 to 12 formed directly on the substrate.

30 17. The barrier laminate according to claim 16, wherein the substrate is a polar or non-polar substrate.

18. The barrier laminate according to claim 16 or 17, wherein the substrate is one or more of: paper, plastic and metal.

19. The barrier laminate according to claim 16, wherein the substrate is a non-polar polymeric substrate.