Claims

1. A multilayer foil comprising at least a layer A and a layer D adjacent to the layer A, wherein the layer A consists of a moulding composition comprising, based on the total weight of the layer A:

from 0.0 to 78.0 wt.-% of a polyalkyl (meth)acrylate
from 20.0 to 98.0 wt.-% of one or several impact modifiers
from 2.0 to 40.0 wt.-% of particulate silica, wherein the particulate silica has a silanol group density of not lower than 0.5 $SiOH/nm^2$,
from 0.0 to 20.0 wt.-% of an adhesion-promoting copolymer comprising, based on the weight of the adhesion-promoting copolymer:
(i) from 70.0 to 99.5 wt.-% methyl methacrylate
(ii) from 0.5 to 15.0 wt.-% of an adhesion-promoting monomer; and
(iii) from 0.0 to 25.0 wt.-% of other vinyl-copolymerizable monomers having no functional groups other than the vinyl function
from 0.0 to 38.0 wt.-% of a fluoropolymer
from 0.0 to 5.0 wt.-% of one or several UV absorbers
from 0.0 to 5.0 wt.-% of one or several UV stabilizers; and

wherein the cumulative content of the polyalkyl (meth)acrylate and of one or several impact modifiers in the moulding composition of the layer A is at least 50 wt.-%, preferably at least 60 wt.-%, more preferably at least 70 wt.-%, yet even more preferably at least 80 wt.-%, particularly preferred at least 85 wt.-%, based on the weight of the layer A; and

the layer D comprises at least a partially cross-linked material selected from cross-linked polyurethanes, cross-linked polyurethane-(meth)acrylates, cross-linked poly(meth)acrylates or a mixture thereof.

2. Foil according to Claim 1, further comprising a layer B adjacent to the layer A, wherein the layer B consists of a moulding composition comprising, based on the total weight of the layer B:

from 0.0 to 100.0 wt.-% of a polyalkyl (meth)acrylate
from 0.0 to 95.0 wt.-% of one or several impact modifiers
from 0.0 to 40.0 wt.-% of a fluoropolymer
from 0.0 to 5.0 wt.-% of one or several UV absorbers
from 0.0 to 5.0 wt.-% of one or several UV stabilizers; and
from 0.0 to 20.0 wt.-% of an adhesion-promoting copolymer comprising, based on the weight of the adhesion-promoting copolymer:
(i) from 70.0 to 99.5 wt.-% methyl methacrylate
(ii) from 0.5 to 15.0 wt.-% of an adhesion-promoting monomer; and

(iii) from 0.0 to 25.0 wt.-% of other vinyl-copolymerizable monomers having no functional groups other than the vinyl function; and

wherein the cumulative content of the polyalkyl (meth)acrylate and of one or several impact modifiers in the moulding composition of the layer B is at least 50 wt.-%, preferably at least 60 wt.-%, more preferably at least 70 wt.-%, yet even more preferably at least 80 wt.-%, still more preferably at least 90 wt.-%, particularly preferably at least 95 wt.-%, based on the weight of the layer B.

3. Foil according to any of Claims 1 to 2, wherein the content, in wt.-%, based on the total weight of the layer A, of one or several impact modifiers n_{im} in the polyalkyl (meth)acrylate foil is described by the following relationship:

$$0.01*n_{im} \leq n_{si} \leq 0.4*n_{im}$$

n_{si} being the content, in wt.-%, of particulate silica in the foil.

4. Foil according to any of Claims 1 to 3, wherein the particulate silica has a specific surface area, measured by BET method according to ISO 9277, of more than 200 m^2/g, preferably more than 300 m^2/g, more preferably more than 400 m^2/g, even more preferably more than 500 m^2/g.

5. Foil according to any of Claims 1 to 4, wherein the particulate silica is a precipitated silica or a pyrogenic silica, preferably a hydrophilic precipitated silica or a hydrophilic pyrogenic silica.

6. Foil according to any of Claims 1 to 5, wherein the particulate silica is a precipitated silica which preferably has a weight average particle size d_{50} of from 1.0 µm to 20.0 µm, preferably from 2.0 µm to 15.0 µm, determined by laser diffraction according to ISO 13320.

7. Foil according to any of Claims 1 to 6, wherein the particulate silica has a silanol group density of from 0.5 to 20.0 $SiOH/nm^2$, even more preferably from 1.0 to 15.0 $SiOH/nm^2$, even more preferably from 1.5 to 10.0 $SiOH/nm^2$.

8. Foil according to any of Claims 1 to 7, wherein the particulate silica has DBP absorption of 100 to 500 g/100 g, preferably 150 to 450 g/100 g, even more preferred 150 to 400 g/100 g, determined in accordance with ASTM D6854-12a.

9. Foil according to any of Claims 1 to 8, wherein the particulate silica has a tamped density from 10 g/l to 800 g/l, more preferably from 40 g/l to 500 g/l, even more preferably from 80 g/l to 300 g/l, determined in accordance with DIN EN ISO 787-11.

10. Foil according to any of Claims 1 to 9, wherein the polyalkyl (meth)acrylate is polymethyl methacrylate having a mass average molar weight Mw of from 50 000 g/mol to 180 000 g/mol, preferably from 80 000 g/mol to 160 000 g/mol, and is obtainable by polymerization of a composition whose polymerizable constituents comprise, based on the weight of the polymerizable composition:

(a) from 50.0 to 99.9 wt.-% of methyl methacrylate
(b) from 0.1 to 50.0 wt.-% of an acrylic acid ester of a C1-C4 alcohol
(c) from 0.0 to 10.0 wt.-% of at least one further monomer copolymerizable with the monomers (a) and (b).

11. Foil according to any of Claims 1 to 10, wherein the one or several impact modifiers are particulate impact modifiers selected from core, core-shell, core-shell-shell and core-shell-shell-shell type impact modifiers.

12. Foil according to any of Claims 1 to 11, wherein the layer B comprises, based on the total weight of the layer B:

from 0.5 to 4.0 wt.-% of a benzotriazole type compound as a first UV absorber
from 0.5 to 3.0 wt.-% of a triazine type compound as a second UV absorber; and
from 0.2 to 2.0 wt.-% of a HALS type compound as a UV stabilizer.

13. Foil according to any of Claims 1 to 12, wherein the foil further comprises a layer C, wherein the layer B is located between the layer A and the layer C,
the layer B consists of a moulding composition comprising, based on the total weight of the layer B:

from 0.0 to 100.0 wt.-% of a polyalkyl (meth)acrylate
from 0.0 to 95.0 wt.-% of one or several impact modifiers
from 0.0 to 40.0 wt.-% of a fluoropolymer
from 0.0 to 5.0 wt.-% of one or several UV absorbers
from 0.0 to 5.0 wt.-% of one or several UV stabilizers; and

the layer C consists of a moulding composition comprising

from 0.0 to 78.0 wt.-% of a polyalkyl (meth)acrylate
from 20.0 to 98.0 wt.-% of one or several impact modifiers
from 0.0 to 40.0 wt.-% of particulate silica
from 0.0 to 40.0 wt.-% of an adhesion-promoting copolymer comprising, based on the weight of the adhesion-promoting copolymer:
(i) from 70.0 to 99.5 wt.-% methyl methacrylate
(ii) from 0.5 to 15.0 wt.-% of an adhesion-promoting monomer; and

(iii) from 0.0 to 25.0 wt.-% of other vinyl-copolymerizable monomers having no functional groups other than the vinyl function;

from 0.0 to 5.0 wt.-% of one or several UV absorbers

from 0.0 to 5.0 wt.-% of one or several UV stabilizers; and

wherein the cumulative content of the polyalkyl (meth)acrylate and of one or several impact modifiers in the moulding composition of the layer C is at least 50 wt.-%, preferably at least 60 wt.-%, more preferably at least 70 wt.-%, yet even more preferably at least 80 wt.-%, based on the weight of the layer C; and

the cumulative content of particulate silica and the adhesion-promoting copolymer is at least 2.0 wt.-%, preferably at least 4.0 wt.-%, more preferably at least 6.0 wt.-%, yet even more preferably at least 8.0 wt.-%, based on the weight of the layer C.

14. Foil according to any of Claims 1 to 13, wherein

the layer A has a thickness from 1.0 µm to 150.0 µm
the layer B, if present has a thickness from 15.0 µm to 150.0 µm
the layer C, if present, has a thickness from 1.0 µm to 30.0 µm; and
the layer D has a thickness from 10.0 µm to 50.0 µm.

15. A multi-layer article, preferably a high-pressure laminate, having an outer surface, comprising a substrate which is at least partially covered by a foil comprising a layer A, optionally, a layer B, optionally, a layer C and a layer D as defined in any of Claims 1 to 14, comprising the layers in the following order, starting from the outer surface of the multi-layer article:

- layer D forming the outer surface of the multi-layer article
- layer A
- optionally, layer B; and
- optionally, layer C.

16. Process for manufacturing of a multi-layer article according to Claim 15, the process comprising the following steps i) to iii):

i) a foil comprising the layer A is prepared by extrusion or, if the layers B and, optionally, C are present, a foil comprising the layers A, B and, optionally, C is prepared by co-extrusion;

ii) a coated foil is prepared by coating the layer A of the foil obtained in the step i) with a layer D;

iii) the coated foil obtained in the step ii) is applied onto a substrate by means of lamination or extrusion lamination, wherein the multi-layer article is obtained; and

wherein the coating layer D, if present, comprises a material which undergoes a partial cross-linking in the step ii) and a further cross-linking in the step iii).

17. Process according to Claim 16, wherein the multi-layer article is a high-pressure laminate and the step iii) of coating a substrate with a foil according to any of Claims 1 to 14 is carried out at a pressure of from 1 MPa to 20 MPa, preferably of from 4 MPa to 15 MPa, more preferably from 6 MPa to 10 MPa and a temperature of from 120 °C to 220 °C.