Abstract:
The present invention relates to a process for producing a foam composite element comprising the steps of providing an outer layer, applying an adhesion promoter layer to the outer layer, wherein the adhesion promoter layer contains an adhesion promoter dispersion, and applying a foam layer containing polyurethane and/or polyisocyanurate to the adhesion promoter layer. The applied adhesion promoter dispersion contains polychloroprene dispersed in water. The invention also relates to the use of an aqueous polychloroprene dispersion as an adhesion promoter in the production of foam composite elements and foam composite elements produced according to the invention.
Process for producing a foam composite element by means of an adhesion promoter dispersion

The present invention relates to a process for producing a foam composite element comprising the steps of providing an outer layer, applying an adhesion promoter layer to the outer layer, wherein the adhesion promoter layer contains an adhesion promoter dispersion, and applying a foam layer containing polyurethane and/or polyisocyanurate to the adhesion promoter layer. The invention also relates to the use of an aqueous polychloroprene dispersion as an adhesion promoter in the production of foam composite elements and foam composite elements produced according to the invention.

The ban on chlorofluorocarbons as blowing agents in polyurethane (PU) systems means that flammable blowing agents, such as pentanes for example, are often used for the production of composite elements for thermal insulation. Under these conditions, compliance with fire safety requirements is possible only to a limited extent using polyurethane systems containing a high proportion of flame retardants.

For technical reasons a lower flame retardant content is often desirable. For that reason polyisocyanurate foams (PIR foams) are also used for insulation elements, as these have good flame retardant properties even with a reduced content of flame retardants. However, PIR systems have a lower adhesion to most known surfaces in comparison to PU systems.

Polyurethane composite elements which have to fulfil structural tasks, such as wall and roof elements for example, are produced for the construction industry. In these structural elements the adhesion between the foam layer and the outer layers plays an important role. Structural elements with metallic outer layers should have an adhesion value of at least ≥ 0.08 N/mm² in order to be approved for the construction industry. PU systems on metallic outer layers typically have adhesion values of 0.12 to 0.17 N/mm². The known adhesion values of PIR systems are on average less than 0.1 N/mm².
In this connection WO 1999/00559 A1 discloses composite elements having a planar, rigid and cellular polyisocyanurate or polyurethane foam core. There is a metal layer on one side of the polyisocyanurate foam core. The adhesion of the metal layer to the polyisocyanurate foam or polyurethane foam core is improved by the use of an adhesion promoter layer, such as for example a polyurea or polyepoxide. Glass fibres are preferably added to the polyisocyanurate foam or polyurethane foam core for reinforcement and as a flame retardant.

EP 1 516 720 A1 discloses the use of a polyurethane adhesion promoter to improve the adhesion between the layers of a composite element containing a polyisocyanurate foam and outer layers, as well as the composite elements per se and a process for producing the composite elements. Preferred embodiments relate to the use of a reactive two-component polyurethane adhesion promoter which is still reactive when the foam layer and outer layer are brought together. However, this involves a potential risk for users.

The possibility of producing foam composite elements, for use in particular for thermal insulation, in which adhesion promoters not requiring special labelling can be used, would be desirable.

Therefore a process for producing a foam composite element is proposed according to the invention comprising the following steps:

A) provision of an outer layer;

B) application of an adhesion promoter layer on the outer layer, wherein the adhesion promoter layer contains an adhesion promoter dispersion;

C) application of a foam layer containing polyurethane and/or polyisocyanurate on the adhesion promoter layer;

wherein the applied adhesion promoter dispersion contains polychloroprene dispersed in water.
Dispensing with reactive two-component systems as adhesion promoters improves safety at work for users. The foam composite elements produced according to the invention are suitable in particular as thermal insulation elements.

Step A) of the process according to the invention involves the provision of an outer layer. There is initially no further restriction on the material for the outer layer; it can be flexible or rigid and the choice is governed by the purpose for which the composite element is to be used. The thickness of the outer layer can for example be in the range between 1 and 400 µm, preferably in the range between 2 and 300 µm, most particularly preferably in the range between 5 and 200 µm.

In step B) an adhesion promoter layer is applied to the outer layer. This adhesion promoter layer contains an adhesion promoter dispersion. It is possible for the adhesion promoter layer to be identical to the adhesion promoter dispersion and consequently for there to be no components other than the adhesion promoter dispersion in the adhesion promoter layer. The thickness of the adhesion promoter layer can for example be in the range between 1 and 400 µm, preferably in the range between 3 and 300 µm, most particularly preferably in the range between 5 and 200 µm.

A particular property of the adhesion promoter dispersion is that it does not have to be free from water before the foam layer is applied.

It is provided according to the invention for the adhesion promoter dispersion applied to the outer layer to contain polychloroprene dispersed in water. Suitable polychloroprene dispersions are produced by emulsion polymerisation of chloroprene (2-chloro-1,3-butadiene), optionally in the presence of copolymerisable ethylenically unsaturated monomers, in an alkaline medium. Polychloroprene production per se is known to the person skilled in the art. In principle all compounds and mixtures thereof which stabilise the emulsion adequately are suitable as emulsifiers, such as for example the water-soluble salts, in particular the sodium, potassium and ammonium salts, of long-chain fatty acids, colophony and colophony derivatives, higher-molecular-weight alcohol sulfates, aryl sulfonic acids, formaldehyde condensates of aryl sulfonic acids, non-ionic emulsifiers based on polyethylene oxide and
polypropylene oxide, and polymers having an emulsifying effect such as polyvinyl alcohol.

The percentage by weight of polychloroprene in the adhesion promoter dispersion can be in a range from \( \geq 30 \text{ wt.\%} \) to \( \leq 100 \text{ wt.\%} \), preferably from \( \geq 35 \text{ wt.\%} \) to \( \leq 95 \text{ wt.\%} \) and more preferably from \( \geq 40 \text{ wt.\%} \) to \( \leq 90 \text{ wt.\%} \).

Suitable polychloroprenes according to the invention can be produced inter alia in the presence of \( \geq 0 \) parts by weight to \( \leq 20 \) parts by weight, relative to 100 parts by weight of chloroprene, of copolymerisable ethylenically unsaturated monomers in the presence of \( \geq 0 \text{ mmol} \) to \( \leq 1 \text{ mmol} \) of a regulator, relative to 100 g of monomer, at temperatures from \( \geq 0^\circ\text{C} \) to \( \leq 20^\circ\text{C} \) in an alkaline emulsion. Copolymerisable monomers are for example compounds having \( \geq 3 \) to \( \leq 20 \) C atoms and one or two copolymerisable \( \text{C} = \text{C} \) double bonds per molecule. Preferred monomers are 2,3-dichloro-1,3-butadiene, 1-chloro-1,3-butadiene, acrylonitrile, acrylic acid, maleic acid, fumaric acid or ethylene glycol dimethacrylate.

It is possible for the polymers of the polychloroprene dispersion to have a glass transition temperature \( T_g \) of \( \geq -60^\circ\text{C} \) to \( \leq 50^\circ\text{C} \). This value can be determined by means of commercial DSC measuring instruments. At such a glass transition temperature it is advantageous for amorphous polymer phases to be available under process conditions for binding to the outer layer and the foam layer. It is also possible for the glass transition temperature \( T_g \) to be in a range from \( \geq -50^\circ\text{C} \) to \( \leq 40^\circ\text{C} \) or from \( \geq -40^\circ\text{C} \) to \( \leq 30^\circ\text{C} \).

The adhesion promoter dispersion used according to the invention can contain further constituents in addition to polychloroprene. Polyacrylate dispersions, polyurethane dispersions, polyurethane-polyacrylate dispersions, styrene-butadiene dispersions and/or acrylonitrile-butadiene dispersions can be mentioned as examples. Auxiliary substances and fillers can be nanodispersed silica particles, carbon blacks, other dispersible fillers (silica flour, silica sand, barytes, calcium carbonate, chalk, dolomite or talc), stabilisers such as hydrolysis inhibitors, antioxidants, light stabilisers and UV stabilisers, plasticisers, flow control agents, wetting agents (polyphosphates such as sodium hexametaphosphate, naphthalene sulfonic acid, ammonium or sodium...
polyacrylic acid salts), thickeners, dyes, organic and inorganic salts, flame retardants, pigments, biocides, fungicides and/or saponifying agents colloidally dispersed in water.

Tackifying resins, for example unmodified or modified natural resins such as colophony esters, hydrocarbon resins or synthetic resins such as phthalate resins can optionally also be added to the adhesion promoter dispersion in dispersed form. Alkyl phenolic resin and terpene phenolic resin dispersions with softening points of \( \geq 70^\circ C \), particularly preferably \( \geq 110^\circ C \), are preferred. An addition of organic solvents such as for example toluene, xylene, butyl acetate, methyl ethyl ketone, ethyl acetate, dioxane or mixtures thereof or of plasticisers, such as those based for example on adipates, phthalates or phosphates, is likewise possible. It is likewise possible for the adhesion promoter dispersion to contain additional activators. Such activators can be monovalent, divalent or trivalent inorganic salts such as LiCl, KC1, NaCl, ZnCl\(_2\), MgCl\(_2\), CaCl\(_2\), ZnO, MgO, FeCl\(_3\), AlCl\(_3\), A\(_2\)(S0\(_4\))\(_3\) or inorganic or organic acids such as HCl, boric acid, phosphoric acid, acetic acid, glycine or other amino acids, citric acid and the alkali and alkaline-earth metal salts of these acids as well as carbonic acid in gaseous form (CO\(_2\)). These can be used to pre-activate the dispersion, in other words to establish a particular pH.

The adhesion promoter dispersion can also additionally contain hydrophilised polyisocyanates based on preferably aliphatic isocyanates such as isophorone diisocyanate (IPDI), diisocyanatodicyclohexyl methane (H\(_2\)-MDI) and/or hexamethylene diisocyanate (HDI). Water-dispersible polyisocyanate preparations consisting of an aliphatic polyisocyanate and a reaction product of an aliphatic polyisocyanate with a monohydric or polyhydric, non-ionic polyalkylene ether alcohol, for example, are suitable as emulsifiers. Reaction products can be isocyanurates, biurets or allophanates of the cited isocyanates, for example. Polyvinyl pyrrolidone-modified polyisocyanates are also suitable as non-ionic emulsifiers. Polyalkylene oxide ethers or polyether ester alcohols containing carboxylic acid groups are also suitable for use as structural units having a dispersing activity.
The adhesion promoter dispersion can have a viscosity at 23°C, measured in accordance with DIN EN ISO 2555 using a Brookfield viscometer, of ≥ 1 mPa.s to ≤ 200,000 mPa.s, preferably from ≥ 5 mPa.s to ≤ 100,000 mPa.s, more preferably from ≥ 10 mPa.s to ≤ 10,000 mPa.s and particularly preferably from ≥ 20 mPa.s to ≤ 5000 mPa.s. In the process the adhesion promoter dispersion can be applied to the outer layer in an amount from ≥ 10 g/m² to ≤ 300 g/m², for example.

Step C) relates to the application of a foam layer on the adhesion promoter layer. This layer can be present in a thickness of for example ≥ 2 cm to ≤ 100 cm, ≥ 2.5 cm to ≤ 50 cm and preferably ≥ 3 cm to ≤ 20 cm. The foam layer can be applied either as a finished foam or in the form of a reaction mixture which reacts to form the finished foam only on the adhesion promoter layer.

The foam layer containing polyurethane and/or polyisocyanurate is preferably used as a thermal insulation layer in the composite element. It can be obtained by reacting polyisocyanates with isocyanate-reactive compounds in the presence of catalysts, the reaction ratio preferably being chosen such that the ratio of the number of isocyanate groups to the number of isocyanate-reactive groups in the reaction mixture is ≥ 1.8 to ≤ 8 : 1, preferably ≥ 1.9 to ≤ 4 : 1. It is possible for the density of the foam layer to be ≥ 20 g/l to ≤ 300 g/l, for example.

The conventional aliphatic, cycloaliphatic and in particular aromatic diisocyanates and/or polyisocyanates are used as polyisocyanates. Toluylene diisocyanate (TDI), diphenylmethane diisocyanate (MDI) and in particular mixtures of diphenylmethane diisocyanate and polyphenylene polymethylene polyisocyanates (crude MDI) are preferably used.

Suitable compounds having at least two isocyanate-reactive hydrogen atoms are generally those bearing two or more reactive groups such as for example OH groups, SH groups, NH groups, NH₂ groups and CH-acid groups, such as β-diketo groups, in the molecule.

Particularly suitable for use as catalysts are the catalysts forming isocyanurate groups which are known from the prior art, preferably alkali metal salts, such as potassium
octoate and/or potassium acetate, alone or in combination with tertiary amines. Polymer formation, in particular isocyanurate formation, advantageously takes place at temperatures above 60°C.

Blowing agents are preferably added to the reaction of polyisocyanates with polyols. So-called physical blowing agents and optionally water are generally used as blowing agents. Physical blowing agents are understood to be compounds which are dissolved or emulsified in the substances used for foam production and which evaporate under the conditions of foam formation. These include hydrocarbons, for example. It is also possible to dissolve inert gases such as nitrogen, carbon dioxide or noble gases under pressure in the foam-building components.

After step C) in the process according to the invention a further adhesion promoter layer can of course be applied to the foam layer as described in step B), followed by a further outer layer as described in step A). A foam composite element having an outer layer on both sides is then obtained. The process can be performed in a conventional twin-belt line, for example.

In one embodiment of the process according to the invention the adhesion promoter dispersion contains components which are capable of crosslinking with polyols and/or isocyanate groups in a proportion of $\geq 0.05 \text{ wt.\%}$ to $\leq 50 \text{ wt.\%}$, relative to its solids content. The proportion can also be $\geq 0.1 \text{ wt.\%}$ to $\leq 30 \text{ wt.\%}$ or $\geq 0.2 \text{ wt.\%}$ to $\leq 10 \text{ wt.\%}$. The term "capable of crosslinking" here denotes in particular the property of linking two or more monomers, oligomer chains or polymer chains together by means of covalent bonds. Suitable in principle for this purpose are firstly compounds having two or more isocyanate-group-reactive functional groups such as OH groups, SH groups, NH groups, NH$_2$ groups, organic acids and CH acid groups such as $\beta$-diketo groups. Secondly, compounds having hydroxyl-group-reactive functional groups such as NCO groups, acid anhydride groups, carbodiimides or carboxyl groups are suitable. Particles bearing the cited functional groups, in particular OH groups, on their surface are likewise suitable. It is also possible for the crosslinkable components to be contained in the polychloroprene polymer. This can be achieved by copolymerisation with suitable monomers or by subsequent polymer
functionalisation. In this case the specified proportion of crosslinkable components relates to the proportion of monomer or monomer blend in the polychloroprene. The advantage of using crosslinkable components is that they allow better binding and hence adhesion of the adhesion promoter layer to the polyurethane polymer and in particular to the polyisocyanurate polymer.

In a further embodiment of the process according to the invention the applied adhesion promoter dispersion has a solids content of ≥ 20 wt.% to ≤ 80 wt.% The proportion can also be in a range from ≥ 30 wt.% to ≤ 70 wt.% and more preferably from ≥ 40 wt.% to ≤ 65 wt.% The solids content is chosen such that before application of the foam component an adequate but not yet complete film formation has taken place on the substrate. Furthermore, the amount of residual water in the adhesion promoter dispersion available for subsequent bonding of the foam layer must be adjusted such that binding still takes place without the formation of large bubbles in the reactive process due to the reaction of isocyanates with water, which bubbles prevent an effective binding of the foam to the substrate by the adhesion promoter dispersion.

In a further embodiment of the process according to the invention commercial polychloroprene dispersions capable of crystallisation are used, such as Dispercoll C 84, C74, C 2325, C VPUS 2372/1, C XP 2694, C XP 2717 from BMS AG having a solids content of 28-58%, or comparable products from DuPont, Denka, Tosoh, Shangxi, which can differ primarily in terms of molecular weight, degree of crosslinking, pH and rate of crystallisation. In the process according to the invention these products can be blended with other compatible aqueous polymer dispersions, such as polyacrylates, polyvinyl acetates, styrene-butadiene copolymers, and with other common auxiliary substances and additives (see in this regard the company publication "Neoprene Latex" by DuPont and "Formulierung von Kleb- und Dichtstoffen" by Bodo Muller, Walther Rath, Vinzentz Network GmbH & Co KG, 2004).

In a further embodiment of the process according to the invention the adhesion promoter dispersion also contains silicon dioxide particles having an average particle
size of $\geq 1$ nm to $\leq 400$ nm. The specific surface area correlating to the particle size can be between 250 and 1000 m$^2$/g (in accordance with DIN 66131). It is provided for the silicon dioxide particles likewise to be present in dispersed form. A property of silicas is their thickening action in formulations of polychloroprene dispersions, as a result of which the adhesives produced in this way form fine-particle, sedimentation-stable dispersions which have good processing characteristics and good stability even on porous substrates to be bonded. The adhesion promoter dispersion advantageously contains the silicon dioxide particles in an amount from $\geq 1$ wt.% to $\leq 70$ wt.%, preferably $\geq 5$ wt.% to $\leq 50$ wt.%, more preferably $\geq 10$ wt.% to $\leq 20$ wt.%, relative to the total solids content of the adhesion promoter dispersion.

Suitable silicon dioxide particles according to the invention can be obtained on the basis of silica sol, silica gel, pyrogenic silicas, precipitated silicas or mixtures thereof.

Silicic acid sols are colloidal solutions of amorphous silicon dioxide in water and are also known as silicon dioxide sols but mostly as silica sols for short.

The silicon dioxide here is in the form of spherical and surface-hydroxylated particles. The BET specific surface area correlating to the particle size (determined using the method described by G. N. Sears, Analytical Chemistry Vol. 28, N. 12, 1981-1983, December 1956) can be between 15 and 2000 m$^2$/g. The surface of the SiO$_2$ particles has a charge, which is balanced out by a corresponding counterion, causing the colloidal solution to be stabilised. The alkali-stabilised silica sols have a pH of 7 to 11.5 and contain as alkalising agents small amounts of for example Na$_2$O, K$_2$O, Li$_2$O, ammonia, organic nitrogen bases, tetraalkylammonium hydroxides or alkali or ammonium aluminates. Silica sols can also be present in weakly acidic form as semi-stable colloidal solutions. It is also possible to produce cationically adjusted silica sols by coating the surface with $\text{Al}_2(\text{OH})_3\text{Cl}_1$. At no point during the production of the silica sols do the SiO$_2$ particles leave the colloidal dissolved state. Discrete primary particles having high binder efficiency are obtained in this way.

Silica gels are understood to be colloiddally formed or unformed silica of an elastic to solid consistency having a loose to dense pore structure. The silica takes the form of
highly condensed polysilica. Siloxane and/or silanol groups are present on the surface. The silica gels are produced from water glass by reaction with mineral acids. The specific surface area correlating to the particle size can be between 250 and 1000 m²/g (in accordance with DIN 66131).

A distinction is also made between pyrogenic silica and precipitated silica. In the precipitation process water is measured out and then water glass and acid, such as H₂S0₄, are added simultaneously. This causes colloidal primary particles to form which agglomerate as the reaction continues and intergrow to form agglomerates. The specific surface area can be 30 to 800 m²/g (DIN 66131). The primary particles of these silicas in solid form are generally stably crosslinked to form secondary agglomerates.

Pyrogenic silica can be produced by flame hydrolysis or using the arc process. The leading synthesis method for pyrogenic silicas is flame hydrolysis, in which tetrachlorosilane undergoes decomposition in an oxyhydrogen flame. The silica that is formed here is X-ray amorphous. Pyrogenic silicas have significantly fewer OH groups on their virtually pore-free surface than precipitated silica. Pyrogenic silica produced by flame hydrolysis can have a specific surface area of 50 to 600 m²/g (DIN 66131). Silica produced by the arc process can have a specific surface area of 25 to 300 m²/g (DIN 66131).

Preferred adhesion promoter dispersions according to the invention are those in which the SiO₂ particles of the silicon dioxide dispersion are present as discrete, uncrosslinked primary particles. It is likewise preferable for the SiO₂ particles to have hydroxyl groups at the particle surface. Aqueous silica sols are particularly preferably used.

In a further embodiment of the process according to the invention the adhesion promoter dispersion has a residual water content of > 0.5 and < 40 wt.% when the foam layer is applied. The residual water content is preferably ≥ 1 and < 30 wt.% or ≥ 2 and < 30 wt.%. With these residual water contents film formation in the adhesion promoter dispersion is not yet complete and it can still react with the foam layer or with the mixture leading to the foam layer. This improves the adhesion.
In a further embodiment of the process according to the invention the material of the outer layer includes aluminium, steel, bitumen, paper, mineral non-woven fabrics, non-woven fabrics containing organic fibres, plastic sheets, plastic films and/or wooden boards. It is preferable for the outer layer to be an aluminium metal outer layer. An example of an aluminium metal outer layer is an aluminium coil coating in a thickness of 0.6 mm.

In a further embodiment of the process according to the invention the outer layer is heated to a temperature of $\geq 30^\circ$C to $\leq 70^\circ$C before application of the adhesion promoter dispersion. Heating can take place for example in a preheating oven as a component of a conventional twin-belt line. The temperature of the outer layer can also be $\geq 40^\circ$C to $\leq 70^\circ$C. The slightly elevated temperature of the outer layer adjusts the process of crystallisation of the adhesion promoter dispersion to the desired degree and thus improves the contact adhesion properties.

In a further embodiment of the process according to the invention the foam layer can be obtained from the reaction of a reaction mixture containing polyisocyanates and at least one compound selected from the group consisting of polyester polyols and polyether polyols, wherein the molar ratio of isocyanate groups to hydroxyl groups in the reaction mixture at the start of the reaction is $\geq 1:1$ to $\leq 5:1$. In other words, the index of this reaction mixture is 100 to 500. The index can also be $\geq 150$ to $\leq 350$ or $\geq 200$ to $\leq 300$. With such values polyisocyanurate foams are predominantly obtained which as already mentioned manage with lower amounts of flame retardants and yet through the process according to the invention can be stably bonded to outer layers, in particular aluminium outer layers. The polyisocyanurate foam is preferably a rigid foam, defined by its compressive stress at 10% compression of $\geq 100$ kPa to $\leq 300$ kPa. This compressive stress or compressive strength can be determined in accordance with DIN 53421/DIN EN ISO 604. It can also be in a range from $\geq 150$ kPa to $\leq 250$ kPa or from $\geq 180$ kPa to $\leq 280$ kPa.

In a further embodiment of the process according to the invention the density of the foam layer is $\geq 25$ g/l to $\leq 48$ g/l, particularly preferably $\geq 35$ g/l to $\leq 45$ g/l. It can be determined by reference to the standard ISO 845. It is also possible for the density to
be most particularly preferably \( \geq 37 \, g/1 \) to \( \leq 42 \, g/1 \), even more preferably \( \geq 39 \, g/1 \) to \( \leq 40 \, g/1 \). Independently of the above, it is moreover also possible for the foam layer, this generally also being understood to include the foam of the foam layer, to have a closed-cell content of \( \geq 85\% \) to \( \leq 100\% \), preferably \( \geq 90\% \) to \( \leq 100\% \), which can be determined in accordance with DIN ISO 4590. The foam layer can moreover have an average cell diameter in accordance with ASTM 3576-77 of \( \geq 10 \, \mu m \) to \( \leq 600 \, \mu m \), preferably \( \geq 50 \, \mu m \) to \( \leq 400 \, \mu m \).

The present invention likewise relates to the use of an aqueous polychloroprene dispersion as an adhesion promoter in the production of foam composite elements. For further details reference is made to the above embodiments in relation to the process according to the invention. The dispersion is preferably still reactive, in other words not yet completely dry, when the outer layer and foam layer are brought together.

In an embodiment of the use according to the invention the polychloroprene dispersion also contains silicon dioxide particles having an average particle size of \( \geq 1 \, nm \) to \( \leq 400 \, nm \). In order to avoid repetition, reference is made to the above embodiments in their full extent in relation to silicon dioxide particles.

The present invention also provides a foam composite element obtained by a process according to the invention. In the foam composite element the adhesive strength between the outer layer and the foam layer is in particular \( \geq 0.12 \, N/mm^2 \) to \( \leq 0.30 \, N/mm^2 \). The adhesive strength can be determined by reference to the standard DIN 53292. It can also be \( \geq 0.13 \, N/mm^2 \) to \( \leq 0.29 \, N/mm^2 \) or \( \geq 0.14 \, N/mm^2 \) to \( \leq 0.28 \, N/mm^2 \).

In a further embodiment of the foam composite element according to the invention it has a thermal conductivity of \( \leq 35 \, mW/mK \). This can be determined by reference to the standard DIN 52612 (Part 1). It is also possible for the thermal conductivity to be \( \leq 35 \, mW/mK \). The lower limit for the thermal conductivity is not specified to any further extent and can for example be \( \geq 10 \, mW/mK \).

The present invention is illustrated in more detail by the examples below.
A formulation comprising a polychloroprene dispersion and a nanosilica suspension with a wet weight of approximately 150 g/m² was applied as the adhesion promoter.

Production of the formulation

The constituents are combined in a 5-litre beaker and stirred for 1 min at an average of 100 rpm.

The formulation is neutralised at an initial pH of 10.9 by passing over CO₂ and stirring the formulation until the desired pH is reached.

Neutralisation can alternatively be carried out in a static mixer by combining the formulation and CO₂ at an initial liquid pressure of 1 bar and a CO₂ pressure of 2 bar. The necessary amount of CO₂ to obtain a formulation pH of 8 is metered in through a reducing valve. Approximately 3.5 g of CO₂ per litre of formulation are required.

Formulation: Parts / % by wt.

| Dispercoll C VPLS 2372/1 | 58 |
| Dispercoll C 2325 | 25 |
| Dispercoll S 3030 | 17 |

Neutralised with CO₂ to pH 8

Viscosity in accordance with DIN EN ISO 2555 < 100 mPas

Viscosity in accordance with DIN EN ISO 2555, measured after 24 h 2000 mPas

The adhesion promoter dispersion is applied to the substrate by spraying using a conventional low-pressure HVLP spray gun, 1.8 mm nozzle, 1.5 bar.

The adhesive strength was checked by reference to the standard DIN 53292. The test differs from the tensile test performed perpendicular to the plane of the outer layer in accordance with DIN 53292-82 in terms of the different sample thickness and number of outer layers. The test in accordance with DIN 53292-82 is based on the entire thickness of the outer layers. Here the weakest area of the complete sample
determines the location of break. By contrast, the adhesion test in the version

described here allows the adhesion to be assessed from the side.

For sampling purposes a composite element is therefore cut perpendicular to the
outer layers. Square samples are used for the measurement with sides of length
50 mm and a sample height of 15 mm (including the outer layer).

Bubble formation was also checked after annealing at 105°C for 1 h.
Claims

1. Process for producing a foam composite element, comprising the following steps:
   A) provision of an outer layer;
   B) application of an adhesion promoter layer on the outer layer, wherein the adhesion promoter layer contains an adhesion promoter dispersion;
   C) application of a foam layer containing polyurethane and/or polyisocyanurate on the adhesion promoter layer;

   characterised in that the applied adhesion promoter dispersion contains polychloroprene dispersed in water.

2. Process according to claim 1, wherein the adhesion promoter dispersion contains components which can crosslink with polyols and/or isocyanate groups in a proportion of $\geq 0.05 \text{ wt.}\%$ to $\leq 50 \text{ wt.}\%$, relative to its solids content.

3. Process according to claim 1, wherein the applied adhesion promoter dispersion has a solids content of $\geq 20 \text{ wt.}\%$ to $\leq 80 \text{ wt.}\%$.

4. Process according to claim 1, wherein the adhesion promoter dispersion also contains silicon dioxide particles having an average particle size of $\geq 1 \text{ nm}$ to $\leq 400 \text{ nm}$.

5. Process according to claim 1, wherein the adhesion promoter dispersion has a residual water content of $\geq 0.5$ and $< 40 \text{ wt.}\%$ when the foam layer is applied.

6. Process according to claim 1, wherein the material of the outer layer includes aluminium, steel, bitumen, paper, mineral non-woven fabrics, non-woven fabrics containing organic fibres, plastic sheets, plastic films, thermoplastic/elastomer foams and/or wooden boards.

7. Process according to claim 1, wherein the outer layer is heated to a temperature of $\geq 30^\circ\text{C}$ to $\leq 70^\circ\text{C}$ before application of the adhesion promoter dispersion.
8. Process according to claim 1, wherein the foam layer can be obtained from the reaction of a reaction mixture containing polyisocyanates and at least one compound selected from the group consisting of polyester polyols and polyether polyols, wherein the molar ratio of isocyanate groups to hydroxyl groups in the reaction mixture at the start of the reaction is $\geq 100:100$ to $\leq 400:100$.

9. Process according to claim 1, wherein the density of the foam layer is $\geq 35$ g/l to $\leq 48$ g/l.

10. Process according to claim 1, wherein the foam layer has a compressive stress at 10% compression of $\geq 100$ kPa to $\leq 300$ kPa.

11. Use of an aqueous polychloroprene dispersion as an adhesion promoter in the production of foam composite elements.

12. Use according to claim 11, wherein the polychloroprene dispersion also contains silicon dioxide particles having an average particle size of $\geq 1$ nm to $\leq 400$ nm.

13. Foam composite element obtained by a process according to claim 1, characterised in that the adhesive strength between the outer layer and the foam layer is $\geq 0.12$ N/mm$^2$.

14. Foam composite element according to claim 14 having a thermal conductivity of $\leq 35$ mW/mK.