In an aspect, there is provided a composite element having the following layer structure:

(i) 2 mm to 20 mm of metal,

(ii) 10 mm to 100 mm of compact polyurethane formulation, said polyurethane formulation being obtainable by reacting

(a) a compound having at least two isocyanate groups with

(b) polyether polyol,

optionally in the presence of

(c) catalyst and/or

(d) auxiliaries and/or additives,

(e) chain extenders

(iii) 2 mm to 20 mm of metal,

where the compound a) comprising isocyanate groups has an NCO content of 20% to 50% and the polyether polyol (b) is a mixture comprising at least the constituents of polyether polyol (b1) and polyether polyol (b2),

wherein the polyether polyol (b1) has a number-average molecular weight between 3.0×10^3 g/mol and 7.0×10^3 g/mol, preferably between 4.0×10^3 g/mol and 6.0×10^3 g/mol, the polyether polyol (b2) has a number-average molecular weight between 0.15×10^3 g/mol and 2.0×10^3 g/mol, further preferably between 0.15×10^3 g/mol and 1.0×10^3 g/mol, and especially preferably between 0.15×10^3 g/mol and 0.6×10^3 g/mol,

wherein the polyether polyol (b1) is present in the mixture at 50% by weight to 95% by weight, preferably at 55% by weight to 90% by weight and more preferably at 60% by weight to 85% by weight,

the polyether polyol (b2) is present in the mixture at 5% by weight to 50% by weight, and

wherein the equivalents ratio of NCO groups of the isocyanates to the sum total of reactive hydrogen atoms of compounds reactive toward isocyanates is 0.95 to 1.15:1.

In another aspect, there is provided a process for producing composite elements as defined above, which comprises mixing

(a) the compound comprising at least two isocyanate groups with

(b) polyether polyol, where the polyether polyol (b) is a mixture comprising at least the constituents of polyether polyol (b1) and polyether polyol (b2),

optionally in the presence of

(c) catalyst and/or

(d) auxiliaries and/or additives and/or

(e) chain extenders and allowing the mixture to cure in contact with the metal layers.

In another aspect, there is provided the use of composite elements as defined above in vehicles, ships, aircraft or built structures.

In another aspect, there is provided a vehicle, ship, aircraft or built structure comprising composite elements as defined above.

Claims

1. A composite element having the following layer structure:
   (i) 2 mm to 20 mm of metal,
   (ii) 10 mm to 100 mm of compact polyurethane formulation, said polyurethane formulation being obtainable by reacting
   (a) a compound having at least two isocyanate groups with
   (b) polyether polyol,
   optionally in the presence of
   (c) catalyst and/or
   (d) auxiliaries and/or additives,
   (e) chain extenders
   (iii) 2 mm to 20 mm of metal,
   where the compound a) comprising isocyanate groups has an NCO content of 20% to 50% and the polyether polyol (b) is a mixture comprising at least the constituents of polyether polyol (b1) and polyether polyol (b2),

   wherein the polyether polyol (b1) has a number-average molecular weight between 3.0×10^3 g/mol and 7.0×10^3 g/mol, preferably between 4.0×10^3 g/mol and 6.0×10^3 g/mol,
   the polyether polyol (b2) has a number-average molecular weight between 0.15×10^3 g/mol and 2.0×10^3 g/mol, further preferably between 0.15×10^3 g/mol and 1.0×10^3 g/mol, and especially preferably between 0.15×10^3 g/mol and 0.6×10^3 g/mol,

   wherein the polyether polyol (b1) is present in the mixture at 50% by weight to 95% by weight, preferably at 55% by weight to 90% by weight and more preferably at 60% by weight to 85% by weight,
   the polyether polyol (b2) is present in the mixture at 5% by weight to 50% by weight, and

   wherein the equivalents ratio of NCO groups of the isocyanates to the sum total of reactive hydrogen atoms of compounds reactive toward isocyanates is 0.95 to 1.15:1.

2. The composite element according to either of the preceding claims, wherein the polyether polyol (b1) has an average functionality of 1.70 to 2.90, preferably 1.95 to 2.8, further preferably 2.2 to 2.7, further preferably 2.4 to 2.6.

3. The composite element according to any of the preceding claims, wherein the polyether polyol (b2) has an average functionality of 1.9 to 5.9, preferably 2.0 to 4.8, further preferably 2.0 to 4.0, further preferably 2.5 to 3.5 and especially preferably 2.9 to 3.1.

4. The composite element according to any of the preceding claims, wherein the weight figures for the polyether polyols (b1) and (b2) are based on the total weight of the mixture consisting of the polyether polyol (b1) and (b2).

5. The composite element according to any of the preceding claims, wherein the difference in the number-average molecular weight of the polyether polyols (b1) and (b2) is at least 0.5 x 10^3 g/mol, preferably at least 1.0 x 10^3 g/mol, further preferably at least 2.0 x 10^3 g/mol, and especially preferably at least 3.5 x 10^3 g/mol.

6. The composite element according to any of the preceding claims, wherein a chain extender is present.

7. The composite element according to the preceding claim, wherein the chain extender comprises a mixture of diols having 2 to 8 carbon atoms, preferably having 4 to 6 carbon atoms, and the chain extender especially preferably comprises dipropylene glycol and butanediol.

8. The composite element according to any of the preceding claims, wherein the compound having isocyanate groups comprises the isocyanate diphenylmethane 2,4'-, 2,2'- and/or 4,4'-diisocyanate (MDI) and/or polyphenylpolymethylene polyisocyanate, more preferably polyphenylpolymethylene polyisocyanate.

9. The composite element according to any of the preceding claims, wherein the polyurethane has a hardness of more than 45 Shore D, preferably of more than 55 Shore D, measured to DIN 53505.

10. A process for producing composite elements according to any of the preceding claims, which comprises mixing
(a) the compound comprising at least two isocyanate groups with
(b) polyether polyol, where the polyether polyol (b) is a mixture comprising at least the constituents of polyether polyol (b1) and polyether polyol (b2),
optionally in the presence of
(c) catalyst and/or
(d) auxiliaries and/or additives and/or
(e) chain extenders and allowing the mixture to cure in contact with the metal layers.

11. The process according to claim 10, wherein the compound a) comprising isocyanate groups has an NCO content of 20% to 40%, preferably of 20% to 35% and more preferably of 20% to 32%.

12. The process according to claim 10 or 11, wherein the mixture optionally comprising (c) catalyst, (d) auxiliaries and/or additives and/or chain extenders (e) has a viscosity of less

than 6.0 x 10^3 mPas, preferably less than 5.0 x 10^3 mPas and more preferably less than 4.0 x 10^3 mPas, measured to DIN 53019-1 at 23°C.

13. The process according to claim 12, wherein the compound (a) comprising isocyanate groups is the addition product of diisocyanate and a polyol having a molecular weight of 0.076 to 2 x 10^3 g/mol.

14. The use of composite elements according to any of claims 1 to 9 in vehicles, ships, aircraft or built structures.

15. A vehicle, ship, aircraft or built structure comprising composite elements according to any of claims 1 to 9.