

CLAIMS

What is claimed is:

1. A method for delaminating a composite by immersing the composite into a delamination solution; wherein the composite comprises a metal substrate and a coating applied on one side or both sides of the metal substrate, wherein the coating comprises a copolymeric binder; wherein the copolymeric binder comprises a structural unit (a), derived from a monomer selected from the group consisting of a carboxylic acid group-containing monomer, a sulfonic acid group-containing monomer, a phosphonic acid group-containing monomer, a carboxylic acid salt group-containing monomer, a sulfonic acid salt group-containing monomer, a phosphonic acid salt group-containing monomer, and combinations thereof.
2. The method of claim 1, wherein the delamination solution comprises a delamination agent and an aqueous solvent; and wherein the concentration of the delamination agent in the delamination solution is from about 0.5 to 5 M.
3. The method of claim 2, wherein the delamination agent is a weak base selected from the group consisting of sodium carbonate, potassium carbonate, lithium carbonate, rubidium carbonate, cesium carbonate, ammonia, methylamine, dimethylamine, trimethylamine, ethylamine, diethylamine, triethylamine, propylamine, isopropylamine, dipropylamine, diisopropyl amine, isopropyl ethylamine, diisopropylethylamine, n-butylamine, isobutylamine, di n-butylamine, diisobutylamine, tributylamine, tert-butyl amine, pyridine, piperidine, 4-dimethylaminopyridine (DMAP), 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU), 1,5-diazabicyclo[4.3.0]non-5-ene (DBN), N-methylmorpholine (NMM), 1,4-diazabicyclo[2.2.2]octane (DABCO), 2,6-lutidine, and combinations thereof.
4. The method of claim 2, wherein the aqueous solvent is water.
5. The method of claim 2, wherein the aqueous solution comprises water as the major component and a minor component, wherein the proportion of water in the aqueous solvent is greater than 51% and less than 100% by weight; and wherein the minor component is selected from the group consisting of methanol, ethanol, isopropanol, n-propanol, tert-butanol, n-butanol, acetone, dimethyl ketone, methyl ethyl ketone, ethyl acetate, isopropyl acetate, propyl acetate, butyl acetate, and combinations thereof.
6. The method of claim 1, wherein the proportion of structural unit (a) within the copolymer is from about 40% to about 80% by mole, based on the total number of moles of monomeric units in the copolymeric binder.
7. The method of claim 1, wherein the carboxylic acid group-containing monomer is selected from the group consisting of acrylic acid, methacrylic acid, crotonic acid, 2-butyl crotonic acid, cinnamic acid, maleic acid, maleic anhydride, fumaric acid, itaconic acid, itaconic

anhydride, tetraconic acid, 2-ethylacrylic acid, isocrotonic acid, cis-2-pentenoic acid, trans-2-pentenoic acid, angelic acid, tiglic acid, 3,3-dimethyl acrylic acid, 3-propyl acrylic acid, trans-2-methyl-3-ethyl acrylic acid, cis-2-methyl-3-ethyl acrylic acid, 3-isopropyl acrylic acid, trans-3-methyl-3-ethyl acrylic acid, cis-3-methyl-3-ethyl acrylic acid, 2-isopropyl acrylic acid, trimethyl acrylic acid, 2-methyl-3,3-diethyl acrylic acid, 3-butyl acrylic acid, 2-butyl acrylic acid, 2-pentyl acrylic acid, 2-methyl-2-hexenoic acid, trans-3-methyl-2-hexenoic acid, 3-methyl-3-propyl acrylic acid, 2-ethyl-3-propyl acrylic acid, 2,3-diethyl acrylic acid, 3,3-diethyl acrylic acid, 3-methyl-3-hexyl acrylic acid, 3-methyl-3-tert-butyl acrylic acid, 2-methyl-3-pentyl acrylic acid, 3-methyl-3-pentyl acrylic acid, 4-methyl-2-hexenoic acid, 4-ethyl-2-hexenoic acid, 3-methyl-2-ethyl-2-hexenoic acid, 3-tert-butyl acrylic acid, 2,3-dimethyl-3-ethyl acrylic acid, 3,3-dimethyl-2-ethyl acrylic acid, 3-methyl-3-isopropyl acrylic acid, 2-methyl-3-isopropyl acrylic acid, trans-2-octenoic acid, cis-2-octenoic acid, trans-2-decenoic acid, α -acetoxycrylic acid, β -trans-aryloxyacrylic acid, α -chloro- β -E-methoxyacrylic acid, methyl maleic acid, dimethyl maleic acid, phenyl maleic acid, bromo maleic acid, chloromaleic acid, dichloromaleic acid, fluoromaleic acid, difluoro maleic acid, nonyl hydrogen maleate, decyl hydrogen maleate, dodecyl hydrogen maleate, octadecyl hydrogen maleate, fluoroalkyl hydrogen maleate, maleic anhydride, methyl maleic anhydride, dimethyl maleic anhydride, acrylic anhydride, methacrylic anhydride, methacrolein, methacryloyl chloride, methacryloyl fluoride, methacryloyl bromide, and combinations thereof.

8. The method of claim 1, wherein the carboxylic acid salt group-containing monomer is selected from the group consisting of acrylic acid salt, methacrylic acid salt, crotonic acid salt, 2-butyl crotonic acid salt, cinnamic acid salt, maleic acid salt, maleic anhydride salt, fumaric acid salt, itaconic acid salt, itaconic anhydride salt, tetraconic acid salt, 2-ethylacrylic acid salt, isocrotonic acid salt, cis-2-pentenoic acid salt, trans-2-pentenoic acid salt, angelic acid salt, tiglic acid salt, 3,3-dimethyl acrylic acid salt, 3-propyl acrylic acid salt, trans-2-methyl-3-ethyl acrylic acid salt, cis-2-methyl-3-ethyl acrylic acid salt, 3-isopropyl acrylic acid salt, trans-3-methyl-3-ethyl acrylic acid salt, cis-3-methyl-3-ethyl acrylic acid salt, 2-isopropyl acrylic acid salt, trimethyl acrylic acid salt, 2-methyl-3,3-diethyl acrylic acid salt, 3-butyl acrylic acid salt, 2-butyl acrylic acid salt, 2-pentyl acrylic acid salt, 2-methyl-2-hexenoic acid salt, trans-3-methyl-2-hexenoic acid salt, 3-methyl-3-propyl acrylic acid salt, 2-ethyl-3-propyl acrylic acid salt, 2,3-diethyl acrylic acid salt, 3,3-diethyl acrylic acid salt, 3-methyl-3-hexyl acrylic acid salt, 3-methyl-3-tert-butyl acrylic acid salt, 2-methyl-3-pentyl acrylic acid salt, 3-methyl-3-pentyl acrylic acid salt, 4-methyl-2-hexenoic acid salt, 4-ethyl-2-hexenoic acid salt, 3-methyl-2-ethyl-2-hexenoic acid salt, 3-tert-butyl acrylic acid salt, 2,3-dimethyl-3-ethyl acrylic acid salt, 3,3-dimethyl-2-ethyl acrylic acid salt, 3-methyl-3-isopropyl acrylic acid salt, 2-methyl-3-isopropyl acrylic acid salt, trans-2-octenoic acid salt, cis-2-octenoic acid salt, trans-2-decenoic acid salt, α -acetoxycrylic acid salt, β -trans-aryloxyacrylic acid salt, α -chloro- β -E-methoxyacrylic acid salt,

methyl maleic acid salt, dimethyl maleic acid salt, phenyl maleic acid salt, bromo maleic acid salt, chloromaleic acid salt, dichloromaleic acid salt, fluoromaleic acid salt, difluoro maleic acid salt, and combinations thereof.

9. The method of claim 1, wherein the sulfonic acid group-containing monomer is selected from the group consisting of vinylsulfonic acid, methylvinylsulfonic acid, allylvinylsulfonic acid, allylsulfonic acid, methallylsulfonic acid, styrenesulfonic acid, 2-sulfoethyl methacrylic acid, 2-methylprop-2-ene-1-sulfonic acid, 2-acrylamido-2-methyl-1-propane sulfonic acid, 3-allyloxy-2-hydroxy-1-propane sulfonic acid, allyl hydrogensulfate, vinyl hydrogensulfate, and combinations thereof.

10. The method of claim 1, wherein the sulfonic acid salt group-containing monomer is selected from the group consisting of vinylsulfonic acid salt, methylvinylsulfonic acid salt, allylvinylsulfonic acid salt, allylsulfonic acid salt, methallylsulfonic acid salt, styrenesulfonic acid salt, 2-sulfoethyl methacrylic acid salt, 2-methylprop-2-ene-1-sulfonic acid salt, 2-acrylamido-2-methyl-1-propane sulfonic acid salt, 3-allyloxy-2-hydroxy-1-propane sulfonic acid salt, allyl sulfate salt, vinyl sulfate salt, and combinations thereof.

11. The method of claim 1, wherein the phosphonic acid group-containing monomer is selected from the group consisting of vinyl phosphonic acid, allyl phosphonic acid, vinyl benzyl phosphonic acid, acrylamide alkyl phosphonic acid, methacrylamide alkyl phosphonic acid, acrylamide alkyl diphosphonic acid, acryloylphosphonic acid, 2-methacryloyloxyethyl phosphonic acid, bis(2-methacryloyloxyethyl) phosphonic acid, ethylene 2-methacryloyloxyethyl phosphonic acid, ethyl-methacryloyloxyethyl phosphonic acid, allyl hydrogenphosphate, vinyl hydrogenphosphate, and combinations thereof.

12. The method of claim 1, wherein the phosphonic acid salt group-containing monomer is selected from the group consisting of vinyl phosphonic acid salt, salt of allyl phosphonic acid, salt of vinyl benzyl phosphonic acid, salt of acrylamide alkyl phosphonic acid, salt of methacrylamide alkyl phosphonic acid, salt of acrylamide alkyl diphosphonic acid, salt of acryloylphosphonic acid, salt of 2-methacryloyloxyethyl phosphonic acid, salt of bis(2-methacryloyloxyethyl) phosphonic acid, salt of ethylene 2-methacryloyloxyethyl phosphonic acid, salt of ethyl-methacryloyloxyethyl phosphonic acid, allyl phosphate salt, vinyl phosphate salt, and combinations thereof.

13. The method of claim 1, wherein the copolymer further comprises a structural unit (b), wherein structural unit (b) is derived from a monomer selected from the group consisting of an amide group-containing monomer, a hydroxyl group-containing monomer, and combinations thereof.

14. The method of claim 13, wherein the proportion of structural unit (b) within the copolymer is from about 10% to about 35% by mole, based on the total number of moles of monomeric units in the copolymeric binder.

15. The method of claim 13, wherein the amide group-containing monomer is selected from the group consisting of acrylamide, methacrylamide, N-methyl methacrylamide, N-ethyl methacrylamide, N-n-propyl methacrylamide, N-isopropyl methacrylamide, isopropyl acrylamide, N-n-butyl methacrylamide, N-isobutyl methacrylamide, N,N-dimethyl acrylamide, N,N-dimethyl methacrylamide, N,N-diethyl acrylamide, N,N-diethyl methacrylamide, N-methylol methacrylamide, N-(methoxymethyl)methacrylamide, N-(ethoxymethyl)methacrylamide, N-(propoxymethyl)methacrylamide, N-(butoxymethyl)methacrylamide, N,N-dimethyl methacrylamide, N,N-dimethylaminopropyl methacrylamide, N,N-dimethylaminoethyl methacrylamide, N,N-dimethylol methacrylamide, diacetone methacrylamide, diacetone acrylamide, methacryloyl morpholine, N-hydroxyl methacrylamide, N-methoxymethyl acrylamide, N-methoxymethyl methacrylamide, N,N'-methylene-bis-acrylamide (MBA), N-hydroxymethyl acrylamide, and combinations thereof.

16. The method of claim 1 or 13, wherein the copolymer further comprises a structural unit (c), wherein structural unit (c) is derived from a monomer selected from the group consisting of a nitrile group-containing monomer, an ester group-containing monomer, an epoxy group-containing monomer, a fluorine-containing monomer, and combinations thereof.

17. The method of claim 16, wherein the proportion of structural unit (c) within the copolymer is from about 10% to about 35% by mole, based on the total number of moles of monomeric units in the copolymeric binder.

18. The method of claim 16, wherein the nitrile group-containing monomer is selected from the group consisting of acrylonitrile, α -halogenoacrylonitrile, α -alkylacrylonitrile, α -chloroacrylonitrile, α -bromoacrylonitrile, α -fluoroacrylonitrile, methacrylonitrile, α -ethylacrylonitrile, α -isopropylacrylonitrile, α -n-hexylacrylonitrile, α -methoxyacrylonitrile, 3-methoxyacrylonitrile, 3-ethoxyacrylonitrile, α -acetoxycyrylonitrile, α -phenylacrylonitrile, α -tolylacrylonitrile, α -(methoxyphenyl)acrylonitrile, α -(chlorophenyl)acrylonitrile, α -(cyanophenyl)acrylonitrile, vinylidene cyanide, and combinations thereof.

19. The method of claim 1, wherein the metal substrate is in the form of a foil, sheet, film, or combinations thereof; wherein the metal substrate is selected from the group consisting of stainless steel, titanium, nickel, aluminum, copper, platinum, gold, silver, chromium, zirconium, tungsten, molybdenum, tin, vanadium, zinc, cadmium, iron, cobalt, lead, and alloys thereof.

20. The method of claim 1, wherein the metal substrate is in the form of a porous body having a three-dimensional network structure; wherein the metal substrate is selected from the group consisting of stainless steel, titanium, nickel, aluminum, copper, platinum, gold, silver, chromium, zirconium, tungsten, molybdenum, tin, vanadium, zinc, cadmium, iron, cobalt, lead, and alloys thereof.

21. The method of claim 1, wherein the weight ratio of the composite to the delamination

solution is from about 0.01% to about 50%; and wherein the composite is immersed into the delamination solution at a temperature of from about 10 °C to about 90 °C.