Claims

1. A polymeric-inorganic nanoparticle composition, obtainable by milling a mixture, the mixture comprising one or more nanoparticle compound (A) and one or more polymer compound (B),

(A) wherein the one or more nanoparticle compound is selected from

- the group consisting of metal oxide nanoparticle, metal nitride nanoparticle, metal carbide nanoparticle, and mixtures thereof; or
- the group consisting of oxidized metal nitride nanoparticle, oxidized metal carbide nanoparticle, and mixtures thereof; or
- the group consisting of non-metal oxide nanoparticle, or
- the group consisting of multi or single layered carbonous structures, multi or single walled nanotubes, carbon fullerenes, graphene, carbon black, graphite, and mixtures thereof; or
- mixtures of the foregoing nanoparticle compounds;

and

(B) wherein the one or more polymer compound is obtainable by polymerizing a monomer composition comprising:

a) one or more functional monomer selected from the list consisting of:

a1) hydroxyalkyl (meth)acrylates;

a2) aminoalkyl (meth)acrylates and aminoalkyl (meth)acrylamides;

a3) nitriles of (meth)acrylic acid and other nitrogen-containing (meth)acrylates;

a4) aryl (meth)acrylates, where the acryl residue in each case can be unsubstituted or substituted up to four times;

a5) carbonyl-containing (meth)acrylates;

a6) (meth)acrylates of ether alcohols;

a7) (meth)acrylates of halogenated alcohols;

a8) oxiranyl (meth)acrylate;

a9) phosphorus-, boron- and/or silicon-containing (meth)acrylates;

a10) sulfur-containing (meth)acrylates;

a11) heterocyclic (meth)acrylates;

a12) maleic acid and maleic acid derivatives;

a13) fumaric acid and fumaric acid derivatives;

a14) vinyl halides;

a15) vinyl esters;

a16) vinyl monomers containing aromatic groups;

a17) heterocyclic vinyl compounds;

a18) vinyl and isoprenyl ethers;

a19) methacrylic acid and acrylic acid,

and

c) from 20 to 80 % by weight of the reaction product of one or more ester of (meth)acrylic acid and one or more hydroxylated hydrogenated polybutadiene having a number-average molecular weight (M_n) of 500 to 10,000 g/mol, based on the total weight of the monomer composition,

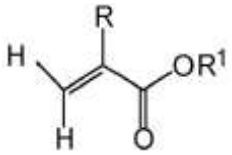
and wherein the weight ratio of the one or more nanoparticle compound (A) to the one or more polymer compound (B) is 20:1 to 1:5.

2. The polymeric-inorganic nanoparticle composition according to claim 1, wherein the hydroxylated hydrogenated polybutadiene of at least one of the one or more ester c) has a number-average molecular weight (M_n) of 1,500 to 2,100 g/mol.

3. The polymeric-inorganic nanoparticle composition according to claim 1 or 2, wherein the monomer composition further comprises as component b) one or more alkyl (meth)acrylate monomer wherein each of the alkyl group of the one or more alkyl (meth)acrylate monomer independently is linear, cyclic or branched and comprises from 1 to 40 carbon atoms.

4. The polymeric-inorganic nanoparticle composition according to claim 3, wherein one or more of the alkyl (meth)acrylate monomer having the linear, cyclic or branched alkyl group which comprises the 1 to 40 carbon atoms independently is

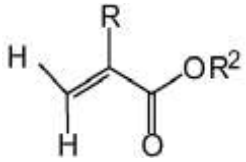
b1) of formula (I):



(I)

wherein R is hydrogen or methyl, R^1 means a linear, branched or cyclic alkyl residue with 1 to 8 carbon atoms, preferably 1 to 5 carbon atoms, and more preferably 1 to 3 carbon atoms, or

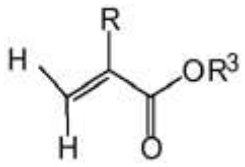
b2) of formula (II):



(II)

wherein R is hydrogen or methyl, R^2 means a linear, branched or cyclic alkyl residue with 9 to 15 carbon atoms, preferably 12 to 15 carbon atoms, and more preferably 12 to 14 carbon atoms, or

b3) of formula (III):



(III)

wherein R is hydrogen or methyl, R^3 means a linear, branched or cyclic alkyl residue with 16 to 40 carbon atoms, preferably 16 to 30 carbon atoms, and more preferably 6 to 20 carbon atoms.

5. The polymeric-inorganic nanoparticle composition according to any one of claims 1 to 4, wherein the one or more polymer compound (B) is obtainable by polymerizing a monomer composition comprising components a) and c), and optionally component b), and wherein the one or more polymer compound (B) has a weight-average molecular weight (M_w) of 10,000 to 1,000,000 g/mol, more preferably 50,000 to 1,000,000 g/mol, even more preferably 100,000 to 800,000 g/mol, most preferably 200,000 to 600,000 g/mol.

6. The polymeric-inorganic nanoparticle composition according to any one of claims 1 to 5, wherein the weight ratio of the one or more nanoparticle compound (A) to the one or more polymer compound (B) is 10:1 to 1:2.

7. The polymeric-inorganic nanoparticle composition according to any one of claims 4 to 6, wherein the one or more polymer compound (B) is obtainable by polymerizing a monomer composition comprising:

a2) 0.5 to 5 % by weight of an aminoalkyl (meth)acrylamide, most preferably N-(3-dimethyl-aminopropyl)methacrylamide, as first component a) based on the one or more polymer compound (B);

a16) 5 to 20 % by weight of a vinyl monomer containing aromatic groups, most preferably styrene, as second component a) based on the one or more polymer compound (B);

b1) 25 to 60 % by weight of an alkyl (meth)acrylate monomer of formula (I), most preferably methyl methacrylate and/or butyl methacrylate, as first component b) based on the one or more polymer compound (B);

b2) 1 to 10 % by weight of an alkyl (meth)acrylate monomer of formula (II), most preferably lauryl methacrylate, as second component b) based on the one or more polymer compound (B); and

c) 25 to 60 % by weight of an ester of a (meth)acrylic acid and a hydroxylated hydrogenated polybutadiene having a number-average molecular weight (M_n) of 500 to 10,000 g/mol, most preferably a macromonomer derived from the reaction of an ester of a (meth)acrylic acid and a hydroxylated hydrogenated polybutadiene having a number-average molecular weight (M_n) of 1,500-5,000 g/mol, as component c) based on the one or more polymer compound (B);

wherein the amounts of all monomers of the monomer composition sum up to 100 % by weight.

8. The polymeric-inorganic nanoparticle composition according to any one of claims 1 to 7, wherein the nanoparticle compound (A) comprises hexagonal boron nitride (hBN) nanoparticle.

9. A method for manufacturing a polymeric-inorganic nanoparticle composition as defined in any one of claims 1 to 8, the method comprising the steps of:
   (a) Providing one or more nanoparticle compound (A);
   (b) providing one or more polymer compound (B);
   (c) preferably, providing a solvent (C);
   (d) combining at least the one or more nanoparticle compound (A) and the one or more polymer compound (B) to obtain a mixture, preferably combining at least the one or more nanoparticle compound (A), the one or more polymer compound (B) and the solvent (C) to obtain a mixture; and
   (e) milling the mixture.

10. Use of the polymeric-inorganic nanoparticle composition according to any one of claims 1 to 8 as an additive for a lubricant composition.

11. A formulation comprising:
   (a) a base oil; and
   (b) a polymeric-inorganic nanoparticle composition according to any one of claims 1 to 8.

12. The formulation according to claim 11, wherein the base oil is selected from the list consisting of an API Group I base oil, an API Group II base oil, an API Group III base oil, an API Group IV base oil and an API Group V base oil, or a mixture of one or more of these base oils.

13. The formulation according to claim 11 or 12, comprising (i) 40 to 95 % by weight, more preferably 70 to 90 % by weight of base oil and (ii) 5 to 60 % by weight, more preferably 10 to 30 % by weight of the polymeric-inorganic nanoparticle composition, based on the total weight of the formulation.

14. The formulation according to claim 11 or 12, comprising (i) 50 to 99.99 % by weight, more preferably 65 to 99.99 % by weight, even more preferably 75 to 99.9 % by weight of base oil and (ii) 0.01 to 50 % by weight, more preferably 0.01 to 35 % by weight, even more preferably 0.1 to 25 % by weight of the polymeric-inorganic nanoparticle composition, based on the total weight of the formulation.