Claims

1. Use of a polymeric-inorganic nanoparticle composition as a heat transfer fluid in battery or other electrical equipment systems, wherein the polymeric-inorganic nanoparticle composition is obtainable by milling a mixture, the mixture comprising one or more inorganic nanoparticle compound (A) and one or more amorphous polymer compound (B),

   (A) wherein the one or more inorganic nanoparticle compound is selected from the group consisting of metal or metalloid oxide nanoparticle, metal or metalloid nitride nanoparticle, metal or metalloid carbide nanoparticle, or a mixture thereof,

   and

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

      a) 1 to 35 % by weight, based on the total weight of the monomer composition, of one or more functional monomer selected from the list consisting of:

         a1) aminoalkyl (meth)acrylates and aminoalkyl (meth)acrylamides;

         a2) nitriles of alkyl (meth)acrylic acid and other nitrogen-containing alkyl (meth)acrylates;

         a3) (meth)acrylates of ether alcohols;

         a4) oxiranyl alkyl (meth)acrylate;

         a5) phosphorus-, boron- and/or silicon-containing alkyl (meth)acrylates;

         a6) heterocyclic alkyl (meth)acrylates;

         a7) vinyl halides;

         a8) vinyl esters;

         a9) vinyl monomers containing aromatic groups;

         a10) heterocyclic vinyl compounds;

         a11) vinyl and isoprenyl ethers;

         a12) methacrylic acid and acrylic acid,

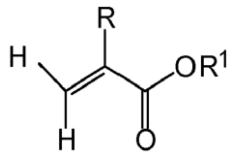
      b) 65 to 99% by weight of one or more alkyl (meth)acrylate monomer, wherein each of the alkyl group of the one or more alkyl (meth)acrylate monomer is independently linear, cyclic or branched and comprises from 1 to 40 carbon atoms, based on the total weight of the monomer composition,

   and wherein the weight ratio of the one or more inorganic nanoparticle compound (A) to the one or more amorphous polymer compound (B) is 9:1 to 1:5.

2. The use according to claim 1, wherein the one or more amorphous polymer compound (B) has a number-average molecular weight (M_n) of 2,000 to 150,000 g/mol, more preferably 5,000 to 100,000 g/mol, even more preferably 5,000 to 80,000 g/mol determined by gel permeation chromatography using polymethylmethacrylate calibration standards and tetrahydrofuran as eluent.

3. The use according to claim 1 or 2, wherein the one or more alkyl (meth)acrylate monomer b) comprises

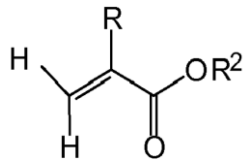
b1) 0 to 20 % by weight of one or more alkyl (meth)acrylate of formula (I), as first component b):



(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 4 carbon atoms, based on the total weight of the monomer composition,

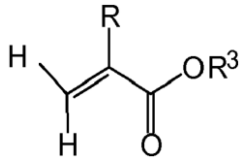
b2) 45 to 99 % by weight of one or more alkyl (meth)acrylate of formula (II), as second component b):



(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, based on the total weight of the monomer composition,

b3) 0 to 30 % by weight of one or more alkyl (meth)acrylate of formula (III), as third component b):



(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 16 to 22 carbon atoms, based on the total weight of the monomer composition.

4. The use according to any one of claims 1 to 3, wherein the amount of monomers a) and b) of the monomer composition sum up to 100 % by weight, based on the total weight of the monomer composition.

5. The use according to any one of claims 1 to 4, wherein the weight ratio of the one or more inorganic nanoparticle compound (A) to the one or more amorphous polymer compound (B) is preferably 9:1 to 1:2, more preferably 3:1 to 1:1.

6. The use according to any one of claims 1 to 5, wherein the monomer component a) is selected from an aminoalkyl (meth)acrylate a1) or an aminoalkyl (meth)acrylamide a1) or a silicon-containing alkyl (meth)acrylate a5) or a heterocyclic alkyl (meth)acrylate a6).

7. The use according to claim 6, wherein the monomer component a) is selected from N-(3-dimethyl-aminopropyl)methacrylamide, 2-dimethylaminoethyl (meth)acrylate, 3-(Trimethoxysilyl)propyl methacrylate; 3-(Triethoxysilyl)propyl methacrylate, or oxazolidinylethyl (meth)acrylate.

8. The use according to any one of claims 1 to 7, wherein the inorganic nanoparticle compound (A) is selected from titanium dioxide, aluminum oxide, or a mixture thereof.

9. The use according to any one of claims 1 to 8, wherein the polymeric-inorganic nanoparticle composition further comprises a base fluid (C), which has a kinematic viscosity at 40 °C from 3 cSt to 30 cSt, preferably from 3 cSt to 25 cSt, according to ASTM D445 and a flash point higher than 110 °C according to ASTM D-93.

10. The use according to claim 9, wherein the base fluid 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, an API Group V base oil, or a mixture thereof.

11. The use according to claim 9 or 10, wherein the polymeric-inorganic nanoparticle composition comprises 80 to 99.9 % by weight of a base fluid (C) and 0.1 to 20 % by weight of (A) and (B), more preferably 85 to 99.9 % by weight of a base fluid (C) and 0.1 to 15 % by weight of (A) and (B), most preferably 88 to 99.5 % by weight of a base fluid (C) and 0.5 to 12 % by weight of (A) and (B), based on the total weight of the polymeric-inorganic nanoparticle composition.

12. The use according to any one of claims 9 to 11, wherein the amounts of (A), (B) and (C) sum up to 100 % by weight, based on the total weight of the polymeric-inorganic nanoparticle composition.

13. The use according to any one of claims 1 to 12, wherein the polymeric-inorganic nanoparticle composition comprising one or more nanoparticle (A), one or more amorphous polymer compound (B) and optionally the base fluid (C) is prepared via ultrahigh pressure technology.

14. The use according to any one of claims 1 to 11 and 13, ~~characterized in that~~wherein the heat transfer fluid further comprises additives selected from the group consisting of antioxidants, anti-wear additives, extreme pressure additives, pour point depressants, demulsifiers, emulsifiers, corrosion inhibitors, metal passivators, rust inhibitors, electrostatic discharge depressants, defoaming agents, seal fix or seal compatibility agents, friction modifiers, dyes or a mixture thereof.

15. The use according to any one of claims 1 to 14, wherein the electrical equipment system is selected from the group consisting of electric batteries, electric motors, electric vehicle transmissions, electric transformers, electric capacitors, fluid-filled transmission lines, fluid-filled power cables, computers and power electronics.