In one embodiment, another layer is grafted onto the particle according to the invention, which layer is obtained by the polymerization of vinyl monomers with 1 to 11 carbon atoms in an aliphatic or aromatic side chain, i.e., R_3 is an aliphatic or aromatic group with 1 to 11 carbon atoms in this case.

For the grafting of another layer, bi- or multifunctional cross-linking agents with at least two differently reactive carbon-carbon double bonds are used.

The particles according to the invention exhibit a first order phase transition in a temperature range of from −20 to 150 °C.

The particles according to the invention are preferably prepared with an average particle diameter of from 100 to 10,000, or from 100 to 2000 nm, preferably from 100 to 500 nm. The average particle diameter d50 is the value for which 50% by weight of all particles are heavier than the stated value, and 50% are lighter than the stated value. Such d50 values are determined, for example, by laser refraction.

Preferably, the particles have a relatively narrow distribution. Thus, the particle diameter d90 value is preferably not greater than three times the d50 value. Thus, for example, if the d50 value is 200 nm, the d90 value is preferably 600 nm or less. The ratio of d90 to d50 values is thus preferably ≤ 3, more preferably ≤ 2.

The particles according to the invention may further comprise from 0 to 10% by weight of inorganic particles. Particularly suitable particles include silicates and oxides of the elements Al, Si, Zr, Hf, Ti, Zn, Pb, and possible mixed oxides thereof.

The invention also relates to a molding composition comprising a matrix and from 1 to 50% by weight of the particles according to the invention, or of particles defined at least by the components a. and b., namely:

Particles obtainable by the polymerization of

especially from 200 to 1000 nm, or from 500 to 1000 nm, comprising, based on their total weight:

A) from 10 to 100% by weight of a polymer phase A, obtainable by free-radical copolymerization of an oil-in-water mini-emulsion with a monomer mixture as the oil phase, comprising

   i) 30 to 99.9% by weight of one or more mono-ethylenically unsaturated monomers I with at least one C_{12}-C_{48} n-alkyl side chain;
   ii) 0 to 60% by weight of one or more mono-ethylenically unsaturated monomers II with at least one C_1-C_{11} n-alkyl and/or one C_3-C_{48} i-alkyl side chain;
   iii) 0.1 to 20% by weight of one or more monomers III with at least two non-conjugated ethylenic double bonds;
   iv) 0 to 69.9% by weight of one or more (hetero)aromatic, mono-ethylenically unsaturated monomers IV;
   v) 0 to 40% by weight of one or more other mono-ethylenically unsaturated monomers V;

and

B) from 0 to 90% by weight of a polymer phase B, obtainable by the subsequent free-radical graft copolymerization, in the presence of the polymer phase A obtained after step A), of a monomer mixture comprising

   i) 0 to 100% by weight of one or more monomers VI from the group of C_1-C_{10} alkyl (meth)acrylates;
   ii) 0 to 100% by weight of one or more (hetero)aromatic mono-ethylenically unsaturated monomers VII;
   iii) 0 to 50% by weight of one or more other mono-ethylenically unsaturated monomers VIII;

wherein the weight percentages of the monomer mixtures employed in the respective steps add up to 100% by weight.

butyl, hydroxyethylcaprolactone, 3-chloro-2-hydroxypropyl, 2-methoxyethyl, 2-ethoxyethyl, 2-butoxyethyl, di(ethylene glycol) methyl ether, di(ethylene glycol) ethyl ether, di(ethylene glycol) 2-ethylhexyl ether, tri(ethylene glycol) methyl ether, ethylene glycol dicyclopentenyl ether, ethyldiglycol, ethyltriglycol, butyldiglycol, 2-carboxyethyl, 2-(dimethylamino)ethyl, 2-(diethylamino)ethyl, 2-(diisopropylamino)ethyl, 2-(tert-butylamino)ethyl, 3-(dimethylamino)propyl, 2-[[(butylamino)carbonyl]oxy]ethyl, glycidyl, 2-(methylthio)ethyl, 3-(trimethoxysilyl)propyl, 2-(trimethylsilyloxy)ethyl, 3-[tris(trimethylsiloxy)silyl]propyl, trimethylsilyl, 2-chloroethyl, 2,2,2-trifluoroethyl, tetrahydrofurfuryl and 2-N-morpholinoethyl (meth)acrylates, and 4-(meth)acryloylmorpholine, mono-2-([meth]acryloyloxy)ethyl succinate, and mono-2-([meth]acryloyloxy)ethyl maleate.

In a preferred embodiment, the monomer phase for forming the polymer phase A comprises:

- 75 to 85% by weight monomer I;
- 5 to 10% by weight monomer II;
- 3 to 6% by weight monomer III, 4 to 6% by weight monomer VI;
- 3 to 5% by weight monomer V.

In other embodiments, the weight percentages of the monomer phase for preparing the polymer phase A are:

- 65 to 75% by weight monomer I;
- 15 to 25% by weight monomer II;
- 3 to 6% by weight monomer III;
- 4 to 6% by weight monomer V.

In other embodiments, preferred contents of the monomer phase for preparing the polymer phase A are:

- 85 to 92% by weight monomer I;
- 3 to 6% by weight monomer III;

employed. Advantageously, the aqueous surfactant solution is also preheated to this temperature in order to prevent the monomer or monomers I from coagulating when the two phases are combined. The aqueous surfactant solution may additionally comprise buffer substances, such as sodium hydrogencarbonate, which provide for an advantageous pH of the aqueous phase in view of the later free-radical polymerization.

In principle, any anionic, cationic and non-ionic surfactants that are also suitable for o/w macroemulsion polymerizations may be used as surfactants. Preferably, anionic and/or non-ionic surfactants are used.

Common anionic surfactants include, for example, alkyl sulfates, alkyl sulfonates, alkylaryl sulfonates, alkyldiphenyloxide disulfonates, alkyl isethionates, alkyl sulfosuccinates, alkyl carboxylates, and alkyl phosphates with typically 8 to 18 carbon atoms in the alkyl radical. The counter-ion is usually an alkali cation (as a rule Na^+), or ammonium (NH_4^+).

Common non-ionic surfactants include, for example, ethoxylates of fatty alcohols, alkylphenols and fatty acids with typically 4 to 36 carbon atoms in the alkyl radical and a degree of ethoxylation of from 3 to 40.

Further common anionic and non-ionic surfactants are known to the skilled person. They are described, for example, in Ullmann's Encyclopedia of Industrial Chemistry, Surfactants, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2012, DOI: 10.1002/14356007.a25_747.

The amount of surfactant is preferably chosen essentially so that the critical micelle concentration (cmc) in the aqueous phase of the finally resulting o/w miniemulsion is not exceeded. As a rule, the amount of surfactant is within a range of from 0.1 to 5% by weight, based on the amount of monomers contained in the o/w miniemulsion.

In order to prevent agglomeration, aggregation, coagulation or flocculation of the primary particles during the polymerization, it may be advantageous to

completed. The monomers are preferably added under such conditions that the formation of new particles is avoided, and the polymer phase B, which forms in this polymerization stage, is deposited as a shell around polymer phase A. Preferably, the monomers are added at the same rate as they are consumed.

Preferably, the monomers necessary for forming polymer phase B are added as an o/w macroemulsion to the aqueous dispersion of polymer phase A. For preparing the o/w macroemulsion, the monomers are mixed with an aqueous surfactant solution, for example, by simple mechanical stirring. The aqueous surfactant solution may additionally comprise buffer substances, in order to provide for an advantageous pH of the aqueous phase in view of the free-radical polymerization.

In principle, all the surfactants mentioned above may be used as said surfactants. Preferably, identical surfactants are used for both polymerization stages (polymer phase A and polymer phase B).

The amount of surfactant in the o/w macroemulsion needed for forming the polymer phase B is preferably chosen so that the critical micelle concentration (cmc) of the surfactant in the aqueous phase containing polymer phase A is not exceeded, in order to minimize the risk of new particle formation. As a rule, the amount of surfactant is within a range of from 0.01 to 2% by weight, based on the amount of monomers contained in the o/w macroemulsion.

Preferably, water-soluble free-radical polymerization initiators are used for forming the polymer phase B. Suitable initiators include the water-soluble free-radical polymerization initiators mentioned above.

The addition of the water-soluble free-radical polymerization initiator may be done at once or over an extended period of time during the polymerization of polymer phase B. Alternatively, part of the polymerization initiator may be added at once, and the remaining part metered over an extended period of time. Preferably, the water-soluble free-radical polymerization initiator is continuously

possibility to mix a polymer directly with a molding composition as a matrix plastic, so that another operation could be omitted.

The primary particle mean diameters of the polymer particles according to the invention are selected from a range of 50 nm to 10 µm, preferably 100 to 2000 nm, more preferably 200 to 1000 nm. Particle diameters in this size range are determined, for example, by laser diffraction. The d50 value is stated as a mean primary particle diameter. d50 means that 50% by weight of the particles are smaller, and 50% by weight of the particles are larger that the stated value. Primary particles means that aggregations/adhesions of the particles among each other are disrupted before the size is measured.

The polymer particles according to the invention may further comprise from 0 to 10% by weight of inorganic nanoparticles. Particularly suitable nanoparticles include silicates and oxides of the elements Al, Si, Zr, Hf, Ti, Zn, Pb, and possible mixed oxides thereof. Preferably, the particle size of these inorganic nanoparticles is within a range of from 5 to 50 nm. Because of such doping, an extended temperature stability is observed in the polymer particles according to the invention.

The invention also relates to a plastic that comprises, based on its total weight:

A) from 1 to 80% by weight of the polymer particles according to the invention;

B) from 20 to 99% by weight of a matrix, consisting of

   i) from 50 to 100% by weight of at least one transparent or translucent matrix plastic; and
   ii) from 0 to 50% by weight of other additives.

Such a plastic is a thermotropic plastic or molding composition, which reversibly changes its light transmission when the temperature changes.

in a sealed flat chamber consisting of two glass sheets with flawless surfaces, and a spacer. For polymerization, the filled flat chamber, in a horizontal or vertical position, is heated at a temperature program adapted to the conversion within a range of 20 to 60 °C for several hours. The final polymerization is effected at temperatures of 110 to 130 °C. Alternatively, thermotropic acrylic glass may also be prepared by a continuous casting method, such as the dual belt method (US 3,376,371).

In principle, the thermotropic molding composition may comprise further ingredients, for example, glidants, antiblocking agents, mold-release agents, stabilizers (antioxidants, light stabilizers, thermal stabilizers), antistatic agents, flame retardants, colorants, impact modifiers, plasticizers, adhesion promoters, fillers, enhancers, blowing agents, etc., and mixtures thereof.

In a particularly simple way, the molding composition can be prepared by mixing the particles according to the invention with the matrix by compounding, for example, in an extruder or kneader.

The thermotropic plastics according to the invention may of course also be used for preparing composite materials. Thus, the thermotropic plastic is bonded to further materials, such as glass, plastic, wood, metal and the like, so that composite materials are obtained, such as, for example, laminated sheets, laminated glasses, glasses coated with a thermotropic adhesive sheet or a thermotropic lacquer. Depending on the matrix plastic, the common methods can be applied for this purpose, such as coextrusion, multicomponent injection molding, adhesive bonding, laminating, casting, spraying, knife coating, flow coating, and the like.

The molding composition according to the invention may then be used for the preparation of final products, for example, by extrusion or injection molding, to obtain molded parts, such as solid plates, multi-skin sheets, corrugated sheets, films, tubes, or the like.

These molded parts obtainable therefrom are suitable, for example, as overheating protection and glare protection in winter gardens, greenhouses, carports, or in the glazing of buildings.

The thermotropic plastics and the thermotropic molded parts or plastic parts prepared therefrom are suitable, for example, for glazings of buildings, vehicles, winter gardens, greenhouses; for glass facades, glass facade elements and curtain walls; for solar glass and light-directing solar glass; for insulating glass, heat-protection glass, and insulating plates; for laminated glass, safety glass, and laminated sound insulating glass; for carports, balcony glazing, terrace roofing, glass houses, indoor swimming pool glazings and roofings; for roof, overhead and fanlight glazing; for industrial glazing; for transparent construction elements, skylight domes, continuous rooflights and barrel vaults; for profiled glass, twin-wall sheets, and panels; for transparent heat insulation; as covers for solar collectors and photovoltaic modules; for sun protection films and lacquers; for agricultural and greenhouse films; as a laminating film for, for example, laminated glass; for indoor glazing, partition walls, room dividers, shower cabinets, glass doors and sliding glass doors; for decorative glass; for luminaire covers, lampshades, reflectors and optical waveguides; for optical lenses and eyeglass lenses or their coatings; for luminous advertising and neon signs; for traffic signs and sign boards, and for packaging.

Figure 1 shows a scanning electron micrograph of the coagulated dry polymerizate from Example 1. The mean primary particle diameter d50 of the polymerizate is within a range of from 100 to 400 nm.

Figure 2 shows two measuring set-ups employed for the optical characterization of specimens.

Figure 3 shows the spectra of the normal-hemispheric transmittance as seen in Example 9.