UNIVERSALLY DISPERSIBLE PARTICLES CONTAINING HYDROGEN BONDS

Innovative solid particles characterized by reversible supramolecular interactions formed by hydrogen bonds can be dispersed in any medium with stability, and are reusable. These new particles have potential application in multiple industries *e.g.* cosmetics, medicine, pharmacology, microelectronics, inks, coatings, pesticides…

Context

Micro- and nanoparticles are used in a wide range of disciplines such as cosmetics, medicine, printing, sensors, coatings, ceramics, dyes etc. However they tend to aggregate when dispersed in a medium, which is then destabilized. This is caused by interaction forces between the particles. One way to stabilize the particles in a dispersing medium is to induce repulsion between the particles by the mean of polymers that are adsorbed or grafted onto their surface. However, this can be done only in medium which can solubilize polymers. Grafted particles with the polymer cannot be dispersed in other media, nor reused nor recycled, as the process is not reversible.

Invention description

The invention provides particles than can be recycled and dispersed in any kind of medium without destabilization. Indeed, the invention corresponds to a particle (P-(A-B-M)$_x$, $x \geq 1$) formed by a solid particle P that is attached to one or several polymer(s) M by supramolecular interactions -A-B- obtained by 2 to 8 hydrogen bonds between hydrogen atoms and heteroatoms within A and B (nitrogen, oxygen, sulfur, phosphorus, fluorine, chlorine, bromine, iodine…). A method to manufacture P-(A-B-M)$_x$ is proposed.

P can be mineral, organic or mixed. P may be a metal, a metal oxide, silica, cellulose particles, carbon nanotubes, graphene sheets, pigments… conductive, magnetic particles; its size can range from 0.005 to 1000µm. P can be attached to polymers M of different chemical nature. A and B are functional groups attached respectively to P and M.
M has a degree of polymerization between 5 and 1000. It can be a stabilizing agent that disperses P in a medium. M is not limited to a specific type of polymer in regards to composition, topology and functionality.
The medium can be any type of liquid medium in which particles can be dispersed *e.g.* solvent, water, aqueous solution, polymer matrix.

The attachment process between A-functionalized solid particle P and B-functionalized polymer M is reversible. The strength of the supramolecular interactions can be adjusted.
The dispersion or aggregation of particle P-(A-B-M)$_x$ can be controlled by changing the temperature, the pH, the ionic strength, light, magnetic or electrical field depending on the type of polymer used.

After being formed, the supramolecular interactions can be broken using a hydrogen-acceptor or a hydrogen-donor small polar. A protic heteroatomic organic molecule can also break the hydrogen bond and thus disrupts -A-B-. Dissociating agents can be dimethyl sulfoxide.

The A-functionalized solid particles P can be recovered by physical separation (*e.g.* filtration, centrifugation) and re-used in another medium.

Added value

The particle can be:
- Dispersed in any kind of medium in a stable way.
- Recovered and reused in another medium multiple times.

This is inherent to the reversible nature of the supramolecular interactions formed by hydrogen bonds.

Potential market

Small size particles can be used in a wide range of fields such as cosmetics, medicine, pharmacology, microelectromechanical systems, printing, inks, inkjet inks, toners, semiconductors, sensors, catalysis, elastomer/polymer reinforcement, coatings, plastic, rubbers, ceramics, colorants, abrasion-resistant polymers, electrophotography, flavor enhancers, pesticides, lubricants.

Intellectual property

US9822194 (granted)

Keywords

Micro/nanoparticles; Functionalized particles; Functionalized polymers; Hydrogen bonds; Solid particle dispersion; Supramolecular interactions; Stable particle dispersion; Particle recycling

Technology domain

Basic materials chemistry; Macromolecular chemistry; Polymers

Technology transfer contact

psl.valo@psl.eu