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(54) **METHOD FOR FABRICATING ANISOTROPIC POLYMER PARTICLES**

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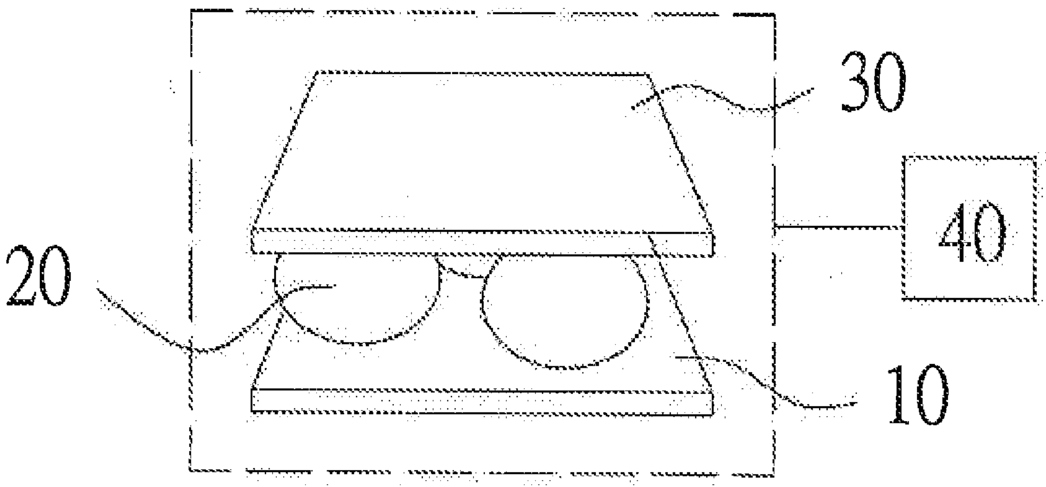
(57) **ABSTRACT**

A method for fabricating anisotropic polymer particles comprises steps: providing a first substrate; arranging a plurality of polymer spheres on the first substrate; providing a second substrate to cover the polymer spheres; heating at least one of the first substrate, the second substrate, and the polymer spheres; and applying force to the first substrate and the second substrate to squeeze the polymer spheres into a plurality of anisotropic polymer particles. The present invention uses simple compressing and heating processes to fabricate many types of anisotropic polymer structures and thus saves the cost and time of fabrication.



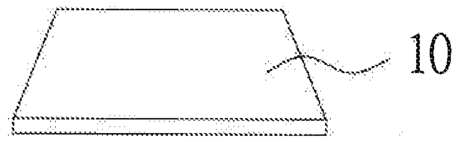


Fig. 1a

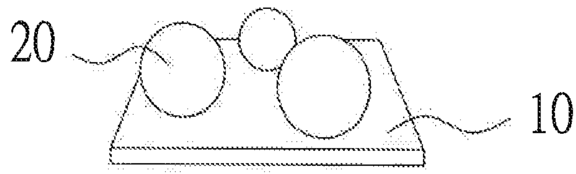


Fig. 1b

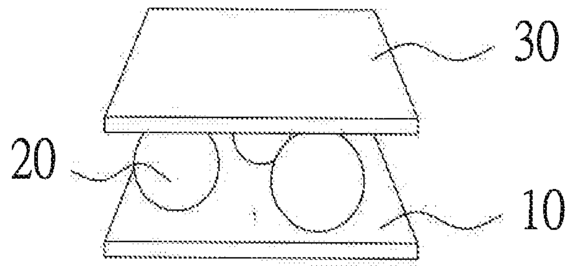


Fig. 1c

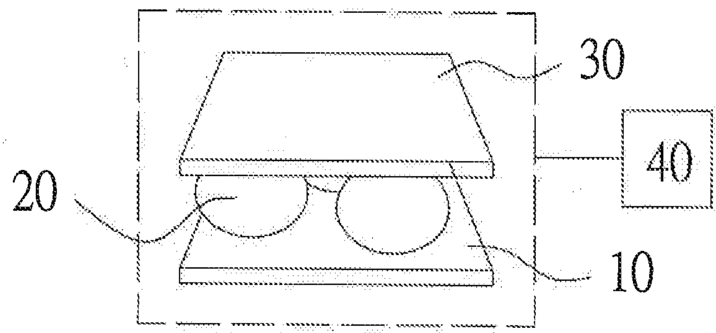


Fig. 1d

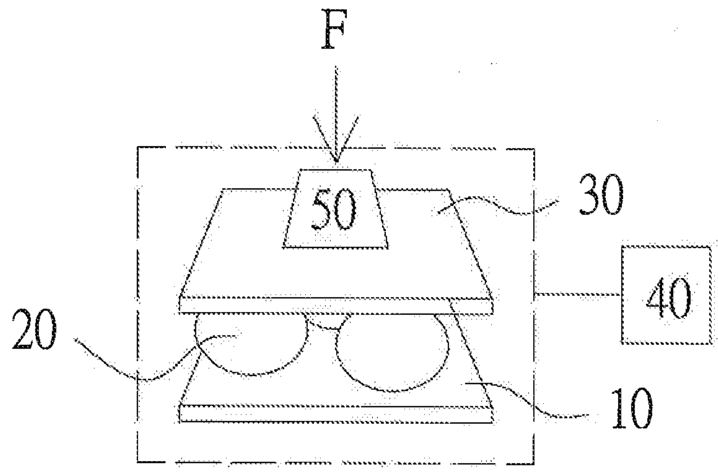


Fig. 1e

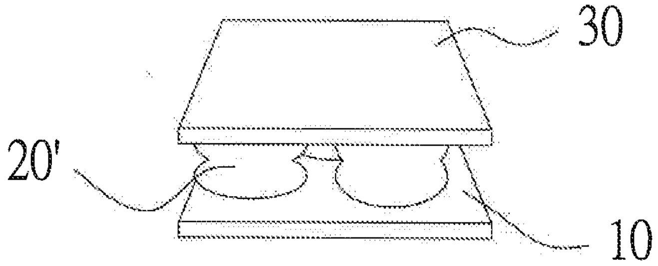


Fig. 1f

METHOD FOR FABRICATING ANISOTROPIC POLYMER PARTICLES

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a method for fabricating polymer particles, particularly to a method for fabricating anisotropic polymer particles.

[0003] 2. Description of the Prior Art

[0004] Polymer microspheres and polymer nanoparticles are the recently emerging materials, applied to medicine vectors, biosensors, inkjet printing inks, etc. In the traditional fabrication process of electronic elements, deposition or etching is normally undertaken in high-temperature reaction environment, such as at a temperature of 200-900° C. As the glass transition temperature Tg of flexible polymer substrates normally ranges from 100 to 200° C., they cannot apply to the traditional process. However, flexible polymer substrates are very suitable to the inkjet printing process, wherein patterns are inkjet-printed on the flexible polymer substrates, and wherein polymer is an ideal material of ink. Biosensors containing biological recognition elements and signal conversion elements are used to measure physiological signals. Molecular imprinting polymers and conductive polymers have biological recognition capabilities and thus apply to biosensors. Polymer nanoparticles for medicine releasing are injected into the body to release medicine inside the body, having special shapes and allowing medicine to be dissolved therein, embedded therein or attached thereto. In the abovementioned technologies, the shape and structure of polymer microspheres or polymer nanoparticles plays a very important role. An appropriate shape of polymer microspheres or polymer nanoparticles enables signal conversion elements, medicine or other materials to stably bind to them.

[0005] In the conventional technology of fabricating anisotropic polymer particles, the particles normally need to be coated with another polymer material before they are stressed and deformed into anisotropic polymer particles. However, the conventional technology can only achieve few types of deformations. Besides, the conventional technology also needs complicated processes to prepare the substrates, such as patterning or activating the substrates.

[0006] If the method for fabricating anisotropic polymer particles has a simpler process and may achieve better deformation effect and more deformation types, the application of anisotropic polymer particles should further expand.

SUMMARY OF THE INVENTION

[0007] One objective of the present invention is to provide a method for fabricating anisotropic polymer particles, which uses compressing and heating processes to fabricate many types of anisotropic polymer structures and thus expands the application of anisotropic polymer particles, and which has a simple process exempted from particle coating and substrate pretreatments and thus saves the cost and time of fabrication.

[0008] In one embodiment, the present invention proposes a method for fabricating anisotropic polymer particles, which comprises steps: providing a first substrate; arranging a plurality of polymer spheres on the first substrate; providing a second substrate to cover the polymer spheres; heating at least one of the first substrate, the second substrate, and the polymer spheres; and applying force to the first substrate and the second substrate to squeeze the polymer spheres into a plurality of anisotropic polymer particles.

[0009] The objective, technologies, features and advantages of the present invention will become apparent from the following description in conjunction with the accompanying drawings wherein certain embodiments of the present invention are set forth by way of illustration and example.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The foregoing conceptions and their accompanying advantages of this invention will become more readily appreciated after being better understood by referring to the following detailed description, in conjunction with the accompanying drawings, wherein:

[0011] FIGS. **1***a*-**1***f* schematically show the steps of a method for fabricating anisotropic polymer particles according to one embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0012] The detailed explanation of the present invention is described as follows. The described preferred embodiments are presented for purposes of illustrations and description, and they are not intended to limit the scope of the present invention.

[0013] Refer to FIGS. **1***a*-**1***f* diagrams schematically showing steps of a method for fabricating anisotropic polymer particles according to one embodiment of the present invention. The method of the present invention comprises steps: providing a first substrate **10** (as shown in FIG. **1***a*); arranging a plurality of polymer spheres **20** on the first substrate **10** (as shown in FIG. **1***b*); providing a second substrate **30** to cover the polymer spheres **20** (as shown in FIG. **1***c*); using a heating device **40** to heat the first substrate **10**, the polymer spheres **20**, and the second substrate **30** (as shown in FIG. **1***d*); applying force to the first substrate **10** and the second substrate **30** to squeeze the polymer spheres **20** (as shown in FIG. **1***e*) into a plurality of anisotropic polymer particles **20'** (as shown in FIG. **1***f*). The polymer spheres **20** are disposed on the first substrate **10** in a spin-coating method or another spreading method. The first substrate **10** is made of a plastic material or a silicon material. The polymer spheres **20** are in form of balls or ellipsoids and have a size ranging from 20 nm to 500 μm. The heating process is undertaken before or after the polymer spheres are covered by the second substrate **30**.

[0014] The deformation of the polymer spheres **20** is realized via both the heating process and the compressing process. If only the compressing process is undertaken, the polymer spheres **20** may be mechanically damaged. The heating process is to modify the surface of the polymer spheres **20**. It is preferred that the polymer spheres **20** are heated to about the glass transition temperature Tg of the polymer spheres **20** to make the polymer spheres **20** have plasticity. The polymer spheres **20** may be heated to a temperature near, equal to or above the glass transition temperature Tg thereof. For example, the polymer spheres **20** may be heated to a temperature of 150-200° C.

[0015] While the polymer spheres **20** is heated to a temperature near Tg, the polymer spheres **20** is modified, and the surface of the polymer spheres **20** appears sticky or wet. Thus, the polymer spheres **20** become deformable and further can wet the surface of the substrates. In one embodiment, the heating process changes the wetness of at least one of the first substrate **10**, the second substrate **30** and the polymer spheres **20** and varies the surface contact interaction of the polymer spheres **20**, the first substrate **10** and the second substrate **30**. The wetness (hydrophilicity or hydrophobicity) will influence the surface contact interaction between the polymer spheres **20** and the substrates. Applying stress F to the wetted polymer spheres **20** will convert the polymer spheres **20** into anisotropic polymer particles **20'**. The shape and structure of the anisotropic polymer particles **20'** depends on the heating temperature and the heating time, which influence the wetness, and also depends on the magnitude of the stress F. The heating process and the compressing process can be undertaken simultaneously or sequentially. In this embodiment, the method of the present invention deforms the polymer spheres **20** merely via heating and compressing, exempted from coating the polymer spheres **20** with a polymer material, complicated pretreatments of the substrates, or chemically activating the substrates. Therefore, the method of the present invention has a simple fabrication process and saves the cost and time of fabrication.

[0016] In the abovementioned embodiment, the present invention does not coat the polymer spheres **20** with another polymer material. However, coating the polymer spheres **20** with another polymer material is still an optional step of the present invention. In some embodiments, the polymer spheres **20** have a coating structure, which is an external film encapsulating an internal sphere to form the polymer sphere **20**.

[0017] The shape and structure of the anisotropic polymer particles **20'** correlate with the heating temperature and the heating time, which influence the wetness of the surface of the polymer spheres **20**. If stress is the dominant factor, the resultant anisotropic polymer particle **20'** has a flattened structure, like the shape of a flattened disc. If heating time is the dominant factor, the resultant anisotropic polymer particle **20'** has a columnar structure with a contracted middle region, like the shape of a dumbbell or a hourglass, as shown in FIG. **1***f*. If heating time has a moderate influence on deformation, the resultant anisotropic poly particle **20'** has a columnar structure with a convex middle region, like the shape of a beer barrel. The abovementioned shapes of the anisotropic particles **20'** are only for exemplification. The present invention does not limit that the anisotropic polymer particle **20'** should have one of the abovementioned shapes.

[0018] In some embodiments, a compressing device **50** or a gravity source **50** is used to apply force F to at least one of the first substrate **10** and the second substrate **30**. In one embodiment, the gravity source **50** is a set of balance weights.

[0019] The polymer spheres **20** are made of at least one material selected from a group consisting of PS (polystyrene), PMMA (polymethylmethacrylate), PLA (polylactide), PCL ((polycaprolactone), PVP (polyvinylpyrrolidone), and PLGA (poly(lactic-co-glycolic acid)). In the present invention, the polymer spheres **20** are made of a single material or a mixture of different materials.

[0020] In conclusion, the present invention proposes a method for fabricating anisotropic polymer particles. The present invention uses simple compressing and heating processes to fabricate many types of anisotropic polymer structures, exempted from particle coating and substrate pretreatments. Thereby, the present invention expands the application of anisotropic polymer particles and saves the cost and time of fabrication.

[0021] While the invention is susceptible to various modifications and alternative forms, a specific example thereof has been shown in the drawings and is herein described in detail. It should be understood, however, that the invention is not to be limited to the particular form disclosed, but to the contrary, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the appended claims.

What is claimed is:

1. A method for fabricating anisotropic polymer particles, comprising steps:

providing a first substrate;

arranging a plurality of polymer spheres on said first substrate;

providing a second substrate to cover said polymer spheres;

heating at least one of said first substrate, said second substrate, and said polymer spheres; and

applying force to said first substrate and said second substrate to squeeze said polymer spheres into a plurality of anisotropic polymer particles.

2. The method for fabricating anisotropic polymer particles according to claim **1**, wherein said polymer spheres are in form of balls or ellipsoids.

3. The method for fabricating anisotropic poly particles according to claim **1**, wherein said polymer spheres are made of at least one material. selected from a group consisting of polystyrene, polymethyl methacrylate, polylactide, polycaprolactone, polyvinylpyrrolidone, and poly lactic-co-glycolic acid.

4. The method for fabricating anisotropic polymer particles according to claim **1**, wherein said polymer sphere has a coating structure, which is an external film encapsulating an internal sphere to form said polymer sphere.

5. The method for fabricating anisotropic polymer particles according to claim **1**, wherein said polymer sphere is made of a single material or a mixture of different materials.

6. The method for fabricating anisotropic polymer particles according to claim **1**, wherein a size of said polymer sphere ranges from 20 nm to 500 μm.

7. The method for fabricating anisotropic polymer particles according to claim **1**, wherein a compressing device or a gravity source is used to apply force to at least one of said first substrate and said second substrate.

8. The method for fabricating anisotropic polymer particles according to claim **7**, wherein said gravity source is a set of balance weights.

9. The method for fabricating anisotropic polymer particles according to claim **1**, wherein said step of heating changes wetness of at least one of said first substrate, said second substrate and said polymer spheres, and varies surface contact interactions of said first substrate, said second substrate and said polymer spheres.

10. The method for fabricating anisotropic polymer particles according to claim **1**, wherein said steps of heating and applying force are undertaken simultaneously.

11. The method for fabricating anisotropic polymer particles according to claim **1**, wherein said step of heating heats said polymer spheres to a temperature near a glass transition temperature of said polymer sp and makes said polymer spheres have plasticity.

12. The method for fabricating anisotropic polymer particles according to claim **1**, wherein said anisotropic polymer particle has a flattened structure, a columnar structure with a contracted middle region, or a columnar structure with a convex middle region.

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