As such, there continues to be a need for the development of new dermal delivery technologies which overcome one or more of the disadvantages experienced with current dermal delivery approaches.

SUMMARY

Dermal delivery compositions are provided. Aspects of the dermal delivery compositions include the presence of active agent-calcium phosphate particle complexes, where these complexes include uniform, rigid, spherical nanoporous calcium phosphate particles associated with one or more active agents. Also provided are methods of using the compositions in active agent delivery applications.

In one aspect, there is provided a topical composition comprising uniform, rigid, spherical nanoporous calcium phosphate particles, wherein at least 90% of the particles have a diameter of 2 microns or less; the particles are chemically pure and are described by the formula $Ca_{10}(PO_4)_6(OH)_2$; and the particles are complexed with an active agent.

BRIEF DESCRIPTION OF THE FIGURES

FIGS. 1A to 2B provide scanning electron microscope images of uniform, rigid, spherical, nanoporous calcium phosphate particles that find use in delivery compositions of the invention.

FIG. 3 provides a graphical representation of the particle size distribution of uniform, rigid, spherical, nanoporous calcium phosphate particles that find use in delivery compositions of the invention.

FIG. 4 shows a visual image of active agent attached to calcium phosphate particles.

FIGS. 5A and 5B shows the tape strip images following application of a 10% calcium phospahte particle slurry to the forearm. FIG. 5A shows calcium phosphate particle penetration to the first layer of the stratum corneum. FIG. 5B shows calcium phosphate particle penetration to the third layer of the stratum corneum.

FIG. 6 is an image of mouse skin prior to application of calcium phosphate particles. No Ca^{++} is evident in the upper statum corneum.

FIGS. 7A shows calcium particles in the upper stratum corneum as well as smaller particles in the lower stratum corneum. FIG. 7B shows the loss of integrity of the spherical calcium particles.

FIG. 8 is a picture showing penetration of CTC fluorescent throughout the stratum corneum following topical application.

WHAT IS CLAIMED IS:

1. A composition comprising uniform, rigid, spherical nanoporous calcium phosphate particles, wherein the particles have an average particle diameter of 2 microns or less and are complexed with an active agent.

2. The composition according to Claim 1, wherein the particles have a pore volume ranging from 30 to 85%.

3. The composition according to Claim 2, wherein the particles have a pore size ranging from 2 nm to 100nm.

4. The composition according to Claim 1, wherein the particles are produced by:

preparing a fluid composition of calcium phosphate crystals;

drying the fluid composition in a manner sufficient to produce precursor particles; and

subjecting the precursor particles to elevated temperature and pressure in a manner sufficient to produce uniform, rigid, spherical nanoporous calcium phosphate calcium phosphate particles.

5. The composition according to Claim 4, wherein the drying comprises spray-drying.

6. The composition according to Claim 1, wherein the composition is a topical formulation.

7. The composition according to Claim 1, wherein the amount of active agent complexed with the particles ranges from 0.01 to 300 mg active agent per gram of particles.

8. A composition comprising:
uniform, rigid, spherical nanoporous calcium phosphate calcium phosphate particles, wherein the particles have an average particle diameter of 2 microns or less and are complexed with an active agent; wherein said composition is to be applied to a topical region of a subject.

9. The composition according to Claim 8, wherein the particles have a pore volume ranging from 30 to 85%.

10. The composition according to Claim 9, wherein the particles have a pore size ranging from 2 nm to 100nm.

11. The composition according to Claim 8, wherein the amount of active agent complexed with the particles ranges from 0.01 to 300 mg active agent per gram of particles.

12. The composition method according to Claim 8, wherein the topical location is a mucosal location.

13. The composition method according to Claim 8, wherein the topical location is a keratinized skin surface.

14. The composition method according to Claim 13, for use in delivering the active agent at least into the stratum corneum of the subject.

15. The composition method according to Claim 13, for use in delivering the active agent into the deep stratum corneum of the subject.

16. The composition according to Claim 13, for use in delivering the active agent through the stratum corneum.

17. The composition according to Claim 13, for use in delivering the active agent into the dermis of the subject.

18. The composition according to Claim 13, for use in systemically delivering the active agent to the subject.

WHAT IS CLAIMED IS:

1. A topical composition comprising uniform, rigid, spherical nanoporous calcium phosphate particles, wherein at least 90% of the particles have a diameter of 2 microns or less; the particles are chemically pure and are described by the formula $Ca_{10}(PO_4)_6(OH)_2$; and the particles are complexed with an active agent.

2. The topical composition according to claim 1, wherein the particles have a pore volume ranging from 30 to 85%.

3. The topical composition according to claim 2, wherein the particles have a pore size ranging from 2 nm to 100 nm.

4. The topical composition according to claim 1, wherein the particles are produced by:

preparing a fluid composition of calcium phosphate crystals;

spray drying the fluid composition to produce precursor particles; and

subjecting the precursor particles to an elevated temperature ranging from 300 to 800 °C. for a period of time ranging from 1 hour to 10 hours to produce uniform, rigid, spherical nanoporous calcium phosphate calcium phosphate particles.

5. The topical composition according to claim 1 further comprising a topical delivery vehicle.

6. The topical composition according to claim 1, wherein the amount of active agent complexed with the particles ranges from 0.01 to 300 mg of active agent per gram of particles.

7. The topical composition according to claim 1, wherein the active agent is selected from the group consisting of antibiotic agents, antifungal agents, anthelmintic agents, antimalarial agents, antiprotozoal agents, cardioprotective agents,

psychopharmacological agents, pharmacodynamics agents and chemotherapeutic agents.

8. The topical composition according to claim 1, wherein the active agent is non-covalently bound to the particles.