

WHAT IS CLAIMED IS:

1. A matting agent for aqueous coating compositions comprising porous silica particles having a low porosity, wherein the low porosity is a total pore volume of less than or equal to about 1.2 cubic centimeters per gram (cc/gm) as determined by Barrett-Joyner-Halenda (BJH) method, and wherein, when incorporated into an aqueous coating composition in an effective matting amount and the coating composition is applied onto a substrate to form a clear coat film, the matting agent provides increased chemical resistance in the film as compared to a film formed from an aqueous coating compositions comprising silica particles having a higher total pore volume as a matting agent.
2. The matting agent of claim 1, wherein the porous silica particles are uncoated silica particles.
3. The matting agent of claim 1, wherein the silica particles are composite silica particles comprising porous silica particles having a total pore volume of at least 0.10 cc/gm or greater; and
(i) one or more waxes, (ii) one or more polymers, or (iii) any combination of (i) and (ii) at least partially within pores of the porous silica particles,
wherein the composite particles have a total pore volume of less than or equal to about 1.2 cc/gm as determined by Barrett-Joyner-Halenda (BJH) method.
4. The matting agent of claim 1 or 3, when incorporated into an aqueous coating composition in an amount sufficient to achieve, upon drying on a plain, smooth and non-penetrating black chart to form a film, a 60° gloss value between 10.0 and 15.0 in a dried film, and enables the film to exhibit a water damage 24 hr ΔL^* of less than 6.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.
5. The matting agent of any one of claims 1 or 3, when incorporated into an aqueous coating composition in an amount sufficient to achieve, upon drying on a plain, smooth and non-penetrating black chart to form a film, a 60° gloss value between 10 to 15 in a dried film, and enables the film to exhibit a 50/50 water/ethanol damage 1 hr ΔL^* of less than 13.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.
6. The matting agent of claim 5, wherein when incorporated into an aqueous coating composition in an amount sufficient to achieve, upon drying on a plain, smooth and non-penetrating black chart to form a film, a 60° gloss value between 10 to 15 in a dried film, and enables the film to exhibit a 50/50

water/ethanol damage 4 hr ΔL^* of less than 15.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.

7. The matting agent of claim 1 or 3, when incorporated into an aqueous coating composition in an amount sufficient to achieve, upon drying on a plain, smooth and non-penetrating black chart to form a film, a 60° gloss value between 10.0 to 15.0 in a dried clear coat film, and enables the film composition to exhibit a film clarity ΔL^* of less than 7.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.

8. The matting agent of claim 3, wherein said composite silica particles comprise up to about 75 weight percent (wt%), based on a total weight of said composite particles, of one of (i) said one or more waxes, (ii) said one or more polymers, or (iii) any combination of (i) and (ii).

9. The matting agent of claim 8, wherein said composite silica particles comprise from about 1.0 wt% to about 70.0 wt%, based on a total weight of said composite particles, of one of (i) said one or more waxes, (ii) said one or more polymers, or (iii) any combination of (i) and (ii).

10. The matting agent of claim 9, wherein said composite silica particles comprise from about 2.0 wt% to about 50.0 wt%, based on a total weight of said composite silica particles, of one of (i) said one or more waxes, (ii) said one or more polymers, or (iii) any combination of (i) and (ii) at least partially within the pores of the porous silica particles.

11. The matting agent of any one of claims 1 or 3, wherein said porous silica particles comprise silica gel, precipitated silica or fumed silica particles.

12. The matting agent of claim 2, wherein said porous silica particles have a total pore volume of from about 0.01 cc/gm to about 1.2 cc/gm, as determined by the BJH method.

13. The matting agent of claim 12, wherein said porous silica particles have a total pore volume of from about 0.1 cc/gm to about 1.0 cc/gm, as determined by the BJH method.

14. The matting agent of any claim 11, wherein the porous silica particles have a BET silica particle surface area of at least about 10 m²/g up to 2000 m²/g, or greater.

15. The matting agent of claim 14, wherein the porous silica particles have a BET silica particle surface area of at least about 20 m²/g up to 900 m²/g.
- 5 16. The matting agent of claim 1 or 3, wherein said porous silica particles have a median particle size of from about 1.0 micron (μm) to about 50 μm.
17. The matting agent of claim 15, wherein said particles have a total pore volume of from about 0.01 cc/gm to about 1.2 cc/gm, as determined by the BJH method.
- 10 18. The matting agent of claim 3, wherein said composite silica particles have a total pore volume of from about 0.01 cc/gm to about 1.2 cc/gm, as determined by the BJH method.
19. The matting agent of claim 3, wherein said composite silica particles comprise porous silica particles and one or more waxes.
- 15 20. The matting agent of 19, wherein said one or more waxes comprise a hydrocarbon wax, a paraffin wax, a polyethylene wax, a polypropylene wax, a plant wax, an animal wax, or any combination thereof.
- 20 21. The matting agent of claim 20, wherein said one or more waxes comprise a polyethylene wax, a polypropylene wax, or a combination thereof.
22. The matting agent of claim 21, wherein said one or more waxes comprise a polyethylene wax having an average molecular weight of at least 2000.
- 25 23. The matting agent of claim 3, wherein said composite silica particles comprise porous silica particles and one or more polymers.
24. The matting agent of claim 23, wherein said one or more polymers comprise polydiene, vulcanized polydiene, polyacrylamide, polyvinyl polypyrrolidone, cellulose acetate butyrate, or any combination thereof.
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25. The matting agent of claim 24, wherein said one or more polymers comprise polydiene, vulcanized polydiene, or any combination thereof.
26. The matting agent of claim 25, wherein said one or more polymers comprise vulcanized polydiene.
27. The matting agent of claim 11, wherein said silica-based particles are free-flowing particles.
28. The matting agent of claim 3, wherein a majority of an outer surface area of said composite silica particles comprises silica.
29. The matting agent of 1 or 3, wherein when incorporated into a coating composition and applied onto a plain, smooth and non-penetrating black chart, enables the coating composition to form a clear coat film having a 60° gloss value between 10.0 to 15.0 as measured using a portable Micro-TRI-Gloss meter.
30. The matting agent of claim 29, wherein the film exhibits a water damage 24 hr ΔL^* of less than 6.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.
31. The matting agent of claim 29, wherein the film exhibits a 50/50 water/ethanol damage 1 hr ΔL^* of less than 13.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.
32. The matting agent of claim 29, wherein the film exhibits a 50/50 water/ethanol damage 4 hr ΔL^* of less than 15.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.
33. The matting agent of any one of claims 30 to 32, when incorporated into a coating composition and applied onto a substrate, enables the coating composition to exhibit a film clarity ΔL^* of less than 7.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.
34. The matting agent of claim 29, wherein the film exhibits (i) a water damage 24 hr ΔL^* of less than 6.0 units as measured using a portable Spectro-Guide 45/0 colorimeter, (ii) a 50/50 water/ethanol damage 1 hr ΔL^* of less than 13.0 units as measured using a portable Spectro-Guide 45/0 colorimeter, (iii) a 50/50 water/ethanol damage 4 hr ΔL^* of less than 15.0 units as measured using a portable Spectro-

Guide 45/0 colorimeter, and (iv) a film clarity ΔL^* of less than 7.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.

35. The matting agent of claim 29, wherein the film exhibits (i) a water damage 24 hr ΔL^* of less than 4.8 units as measured using a portable Spectro-Guide 45/0 colorimeter, (ii) a 50/50 water/ethanol damage 1 hr ΔL^* of less than 11.0 units as measured using a portable Spectro-Guide 45/0 colorimeter, (iii) a 50/50 water/ethanol damage 4 hr ΔL^* of less than 11.5 units as measured using a portable Spectro-Guide 45/0 colorimeter, and (iv) a film clarity ΔL^* of less than 6.5 units as measured using a portable Spectro-Guide 45/0 colorimeter.

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36. A method of preparing the matting agent of claim 3, said method comprising:

contacting porous silica particles having a total pore volume of at least 0.1 cc/gm or greater with (i) one or more waxes, (ii) one or more polymers, or (iii) any combination of (i) and (ii) so as to form the composite silica particles having a total pore volume of less than or equal to 1.2 cc/gm.

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37. The method of claim 36, wherein said contacting step comprises:

dissolving (i) one or more waxes, (ii) one or more polymers, or (iii) any combination of (i) and (ii) in a solvent to form a suspension or dispersion;

incorporating the porous silica particles into the suspension or dispersion; and

20 removing the solvent from the suspension or dispersion to form the composite silica particles.

38. The method of claim 36, wherein said contacting step comprises:

25 melting (i) one or more waxes, (ii) one or more polymers, or (iii) any combination of (i) and (ii) to form a liquid coating; and

incorporating the porous silica particles into the liquid coating to form the composite silica particles.

39. The method of claim 36, wherein said contacting step comprises:

30 simultaneously mixing or milling (a) (i) one or more waxes, (ii) one or more polymers, or (iii) any combination of (i) and (ii), and (b) the porous silica particles with heat to form the composite silica particles.

40. The method of any one of claims 36 to 39, further comprising:
adding elemental sulfur, a vulcanization promoter, or both to the one or more polymers.
41. The method of claim 40, wherein the vulcanization promoter comprises elemental sulfur and/or
5 butyl zimate.
42. The method of any one of claims 36 to 41, further comprising:
reducing the particle size of the composite silica particles to obtain composite silica
particles having a final particle size of less than 100 microns (μm).
- 10 43. The method of claim 42, further comprising:
forming composite silica particles having a first particle size of less than about 500
microns (μm);
heat treating the composite silica particles at an elevated temperature for a heat treatment
15 period of time;
allowing the heat-treated composite silica particles to cool; and
milling the heat-treated composite silica particles so as to result in a final particle size of
less than about 100 μm .
- 20 44. The method of claim 43, wherein the composite silica particles are heat treated at elevated
temperature ranges from about 90°C to about 140°C, and the heat treatment period of time ranges from
about 1.0 hour (hr) to about 4.0 hr.
45. The method of claim 44, wherein one or more waxes are present, and the elevated temperature
25 ranges from about 100°C to about 130°C, and the heat treatment period of time ranges from about 1.0 hr
to about 1.5 hr.
46. The method of claim 44, wherein one or more polymers are present, and the elevated temperature
ranges from about 90°C to about 100°C, and the heat treatment period of time ranges from about 2.5 hr
30 to about 3.5 hr.
47. The method of claim 42, wherein said reducing step results in coated particles having a final
particle size of less than about 45 μm .

48. A coating composition comprising the matting agent of any one of claims 1 to 35.
49. The coating composition of claim 48, wherein said composition comprises an aqueous composition.
50. The coating composition of claim 49, wherein said composition comprises up to about 50 wt% of said matting agent based on a total weight of said coating composition.
51. The coating composition of claim 49, when applied onto a plain, smooth and non-penetrating black chart, forms a film having a 60° gloss value between 10.0 to 15.0, as measured using a portable Micro-TRI-Gloss meter.
52. The coating composition of claim 51, wherein the film exhibits a water damage 24 hr ΔL^* of less than 6.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.
53. The coating composition of claim 51, wherein the film exhibits a 50/50 water/ethanol damage 1 hr ΔL^* of less than 13.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.
54. The coating composition of claim 51, wherein the film exhibits a 50/50 water/ethanol damage 4 hr ΔL^* of less than 15.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.
55. The coating composition of claim 51, wherein the film exhibits a film clarity ΔL^* of less than 7.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.
56. The coating composition of claim 51, wherein the film exhibits (i) a water damage 24 hr ΔL^* of less than 6.0 units as measured using a portable Spectro-Guide 45/0 colorimeter, (ii) a 50/50 water/ethanol damage 1 hr ΔL^* of less than 13.0 units as measured using a portable Spectro-Guide 45/0 colorimeter, (iii) a 50/50 water/ethanol damage 4 hr ΔL^* of less than 15.0 units as measured using a portable Spectro-Guide 45/0 colorimeter, and (iv) a film clarity ΔL^* of less than 6.5 units as measured using a portable Spectro-Guide 45/0 colorimeter.

57. The coating composition of claim 51, wherein the film exhibits (i) a water damage 24 hr ΔL^* of less than 4.8 units as measured using a portable Spectro-Guide 45/0 colorimeter, (ii) a 50/50 water/ethanol damage 1 hr ΔL^* of less than 11.0 units as measured using a portable Spectro-Guide 45/0 colorimeter, (iii) a 50/50 water/ethanol damage 4 hr ΔL^* of less than 11.5 units as measured using a
5 portable Spectro-Guide 45/0 colorimeter, and (iv) a film clarity ΔL^* of less than 6.0 units as measured using a portable Spectro-Guide 45/0 colorimeter.

58. A substrate coated with the coating composition of any one of claim 48 to 57.

10 59. The substrate of claim 58, wherein said substrate comprises a wood substrate.

60. A method of improving chemical resistance of a waterborne composition applied to a wood substrate, said method comprising:

15 incorporating the matting agent of any one of claims 1 and 3 into the coating composition;
applying the coating composition onto at least one surface of a wood substrate to form a coating; and
drying the coating to form a film on at least one surface of the wood substrate.

61. The method of claim 60, wherein in film is a clear coat film.

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