Claims

1. A matting formulation for aqueous coating composition comprising high pore volume silica particles blended with an amount of low pore volume silica particles that is sufficient to provide, when the matting formulation is incorporated into an aqueous coating composition and dried onto a substrate to form a film, a film having increased chemical resistance at a 60° gloss value target, wherein the high pore volume silica particles have a median pore volume of greater than 0.80 cc/g as determined by Barrett-Joyner-Halenda (BJH) method and the low pore volume silica particles have a median pore volume equal to or less than 0.80 cc/g or less as determined by the BJH method.

2. The matting formulation of claim 1, wherein the 60° gloss value target is between about 3.0 and about 30.0 as measured using a portable Micro-TRI-Gloss meter, preferably between about 5.0 and about 20.0, more preferred between about 10.0 to about 15.0.

3. The matting formulation of any one of claims 1 and 2, wherein, when incorporated into the aqueous coating composition and applied onto a substrate, enables the coating composition to form a film having a chemical resistance rating of from 3 to 5 within a scale of 1 to 5 using test method EN 12720 or DIN68861-1.

4. The matting formulation of any one of claims 1 to 3, wherein the film is a clear coat film.

5. The matting formulation of any one of claims 1 to 4, wherein the substate is wood, plastics, or black chart paper.

6. The matting formulation of any one of claims 1 to 5, wherein the aqueous coating composition, when applied onto a plain, smooth and non-penetrating black chart paper and dried, forms a film having a 50/50 water/ethanol damage 1 hr AL* value equal to or less than 10.0 units as measured using a portable Spectro-Guide 45/0 colorimeter, preferably equal to or less than 7.0 units, more preferred equal to or less than 5.0 units, still more preferred equal to or less than 3.0 units.

7. The matting formulation of any one of claims 1 to 6, wherein the aqueous coating composition, when applied onto a plain, smooth and non-penetrating black chart paper

and dried, forms a film having a film clarity AL* equal to or less than 7.0 units as measured using a portable Spectro-Guide 45/0 colorimeter, preferably equal to or less than 6.0 units, more preferred equal to or less than 5.0 units, still more preferred equal to or less than 4.5 units.

8. The matting formulation of any one of claims 1 to 7, wherein said low pore volume silica particles are present in an amount of from about 1.0 weight percent (wt%) to about 99.0 wt%, and said high pore volume silica particles are present in an amount of from about 99.0 wt% to about 1.0 wt%, based on a total weight of said low pore volume silica particles and said high pore volume silica particles, wherein preferably said low pore volume silica particles are present in an amount of from about 50.0 wt% to about 98.0 wt%, and said high pore volume silica particles are present in an amount of from about 50.0 wt% to about 2.0 wt%, based on a total weight of said low pore volume silica particles and said high pore volume silica particles, wherein more preferred said low pore volume silica particles are present in an amount of from about 60.0 wt% to about 95.0 wt%, and said high pore volume silica particles are present in an amount of from about 40.0 wt% to about 5.0 wt%, based on a total weight of said low pore volume silica particles and said high pore volume silica particles.

9. The matting formulation of any one of claims 1 to 8, wherein the pore volume of the low pore volume silica particles differs from the pore volume of the high pore volume silica particles by at least 0.1 cc/g, wherein the pore volume of said low pore volume silica particles preferably is at least 0.2 cc/g less than the median pore volume of said high pore volume silica particles, wherein the pore volume of said low pore volume silica particles more preferred is at least 0.50 cc/g less than the pore volume of said high pore volume silica particles, still more preferred at least 0.80 cc/g less than the pore volume of said high pore volume silica particles.

10. The matting formulation of any one of claims 1 to 9, wherein said low pore volume silica particles have a pore volume of from about 0.01 cc/g to about 0.79 cc/g as determined by the BJH method, preferably about 0.01 cc/g to about 0.60 cc/g.

11. The matting formulation of any one of claims 1 to 10, wherein said high pore volume silica particles have a pore volume of from about 0.80 cc/g to about 2.40 cc/g as determined by the BJH method, preferably about 0.90 cc/g to about 2.00 cc/g.

12. The matting formulation of any one of claims 1 to 11, wherein said high pore volume silica particles and said low pore volume silica particles consist essentially of silica.

13. The matting formulation of any one of claims 1 to 11, wherein said low pore volume silica particles further comprise one or more first waxes in an amount sufficient to at least partially fill pores of said low pore volume silica particles, wherein said low pore volume silica particles preferably comprise from about 5.0 wt% to less than about 65.0 wt% of said one or more first waxes, based on a total weight of said low pore volume silica particles, more preferred about 10.0 wt% to less than about 60.0 wt% of said one or more first waxes, based on a total weight of said low pore volume silica particles, still more preferred about 15.0 wt% to less than about 55.0 wt% of said one or more first waxes, based on a total weight of said low pore volume silica particles.

14. The matting formulation of any one of claims 1 to 11 and 13, wherein said high pore volume silica particles further comprise one or more second waxes in an amount sufficient to at least partially fill pores of the high pore volume silica particles, wherein said high pore volume silica particles preferably comprise from about 5.0 wt% to less than about 65.0 wt% of said one or more second waxes, based on a total weight of said high pore volume silica particles, more preferred about 10.0 wt% to less than about 60.0 wt% of said one or more second waxes, based on a total weight of said high pore volume silica particles, still more preferred about 15.0 wt% to less than about 55.0 wt% of said one or more second waxes, based on a total weight of said high pore volume silica particles.

15. The matting formulation of any one of claims 13 and 14, wherein each of said one or more first waxes and said one or more second waxes independently comprises a hydrocarbon wax, a paraffin wax, a polyethylene wax, a polypropylene wax, a plant wax, an animal wax, or any combination thereof, preferably independently comprises a polyethylene wax, a polypropylene wax, or a combination thereof, more preferred independently

comprises a polyethylene wax having an average molecular weight of at least 2000, still more preferred comprises the same one or more waxes.

16. The matting formulation of any one of claims 1 to 15, wherein each of said low pore volume silica particles and said high pore volume silica particles independently comprises silica gel, precipitated silica, fumed silica particles, or any combination thereof, preferably independently comprises silica gel particles, more preferred independently have a median particle size of from about 1.0 micron (pm) to about 50.0 pm, still more preferred independently have a median particle size of from about 3.0 pm to about 15.0 pm.

17. The matting formulation of any one of claims 1 to 16, wherein said low pore volume silica particles and said high pore volume silica particles are free-flowing particles.

18. A method of preparing the matting formulation of any one of claims 1 to 17, said method comprising:

combining the low pore volume silica particles and the high pore volume silica particles to form a blend of the low pore volume silica particles and the high pore volume silica particles.

19. The method of claim 18, further comprising: contacting the low pore volume silica particles with the one or more first waxes, and/or

further comprising: contacting the high pore volume silica particles with the one or more second waxes,

wherein said contacting step preferably a) comprises:

dissolving or dispersing the one or more first or second waxes in one or more solvents to form one or more suspensions or dispersions;

incorporating the low pore volume silica particles or the high pore volume silica particles into the one or more suspensions or dispersions; and

removing the solvent from the one or more suspensions or dispersions, or

wherein said contacting step preferably b) comprises:

melting the one or more first or second waxes to form one or more molten liquids; and

incorporating the low pore volume silica particles or the high pore volume silica particles into the one or more molten liquids, or

wherein said contacting step preferably c) comprises:

simultaneously mixing and/or milling (a) the one or more first or second waxes, and (b) the low pore volume silica particles or the high pore volume silica particles with heat.

20. The method of any one of claims 18 or 19,

a) further comprising:

reducing the particle size of the low pore volume silica particles or the high pore volume silica particles to obtain silica particles having a final particle size of less than 100 microns (pm), or

b) further comprising:

forming the low pore volume silica particles or the high pore volume silica particles having a first particle size of less than about 500 microns (pm);

heat treating the low pore volume silica particles or the high pore volume silica particles at an elevated temperature for a heat treatment period of time;

allowing the heat-treated low pore volume silica particles or the heat-treated high pore volume silica particles to cool; and

milling the heat-treated low pore volume silica particles or the heat-treated high pore volume silica particles so as to result in a final particle size of less than about 100 pm,

wherein in b) the low pore volume silica particles or the high pore volume silica particles are heat treated at an elevated temperature ranging 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,

wherein the elevated temperature preferably 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.

21. The method of claim 20a), wherein said reducing step results in low pore volume silica particles or high pore volume silica particles having a final particle size of less than about 45.0 pm.

22. A coating composition comprising the matting formulation of any one of claims 1 to 17, wherein said coating composition comprises an aqueous composition.

23. The coating composition of claim 22, wherein said coating composition comprises up to about 16.0 wt% of said matting formulation based on a total weight of said coating composition, preferably about 5.0 wt% to about 15.0 wt% of said matting formulation based on a total weight of said coating composition, more preferred about 7.5 wt% to about 12.5 wt% of said matting formulation based on a total weight of said coating composition.

24. A substrate coated with the coating composition of any one of claim claims 22 and 23, wherein said substrate preferably comprises wood, plastics, or black chart paper.

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

incorporating the matting formulation of any one of claims 1 to 17 into a coating composition;

applying the coating composition onto at least one surface of a wood or plastic substrate to form a coating; and

drying the coating to form a film on at least one surface of the wood or plastic substrate,

wherein the film preferably is a clear coat film.