containing the same, or that may create unwanted health, safety or environmental issues. It is further desired that such methods for making APs enables one to specially engineer AP particles and compositions having certain desired characteristics and/or performance properties not otherwise obtainable using conventional methods of making, to enable the use of such formed APs in a greater variety of end-use applications. Further, it is desired that such methods enable forming APs in a manner that is relatively more cost effective and/or efficient as compared to the conventional methods of forming APs.

SUMMARY

In a first aspect of the present disclosure, there is provided a method for making aluminum phosphate compositions comprising the steps of:
combining ingredients consisting of an aluminum hydroxide slurry formed by combining aluminum hydroxide with water, ~~to form a slurry; adding the aluminum hydroxide slurry to~~and phosphoric acid to form a mixture; and
reacting the mixture for a period of time to form a reaction product comprising amorphous aluminum phosphate condensate in the reaction product.

~~In a second aspect of the present disclosure, there is provided a chemical composition comprising a binding polymer and the aluminum phosphate prepared according to the first aspect.~~

In a ~~third~~ second aspect of the present disclosure, there is provided a method for making amorphous aluminum phosphate compositions comprising the steps of:
combining ingredients consisting of an aluminum hydroxide slurry formed by combining aluminum hydroxide with water, ~~to form a slurry; adding the aluminum hydroxide slurry to~~and phosphoric acid to form an acidic aluminum phosphate solution~~;~~ and
combining the acidic aluminum phosphate solution with a further amount of the aluminum hydroxide slurry to form a mixture; and
reacting the mixture for a period of time to form a reaction product comprising amorphous aluminum phosphate condensate in solution.

~~In a fourth aspect of the present disclosure, there is provided a chemical composition comprising a binding polymer and the aluminum phosphate prepared according to the third aspect.~~

In a ~~fifth~~ third aspect of the present disclosure, there is provided a method for making aluminum phosphate comprising the steps of:
combining ingredients consisting of an aluminum hydroxide slurry formed by combining aluminum hydroxide with water, and ~~to form a slurry; adding the aluminum hydroxide slurry to~~ phosphoric acid to form a mixture; and

reacting the mixture for a period of time to form a reaction product comprising amorphous aluminum phosphate condensate in solution, wherein during the step of reacting the volume of the mixture is variable.

~~In a first embodiment of the fifth aspect, wherein during the step of reacting, water from the mixture is evaporated, and water is added to the reaction product.~~

~~In a second embodiment of the fifth aspect, wherein during the step of reacting, water from the mixture is evaporated, and water is added to the reaction product, and wherein during the step of reacting, aluminum phosphate particles are formed and further aluminum phosphate is disposed onto the already formed aluminum phosphate particles.~~

~~In a sixth aspect of the present disclosure, there is provided aluminum phosphate, formed according to the method of the second embodiment of the fifth aspect, comprising aluminum phosphate particles that are coated with further aluminum phosphate particles.~~

~~In a seventh aspect of the present disclosure, there is provided a chemical composition comprising a binding polymer and the amorphous aluminum phosphate prepared according to the first embodiment of the fifth aspect.~~

In ~~an eighth~~a fourth aspect of the present disclosure, there is provided a method for making aluminum phosphate ~~compositions~~ comprising the steps of

combining ingredients consisting of an aluminum hydroxide slurry formed by combining aluminum hydroxide with water, and ~~to form a slurry, adding to the slurry~~ phosphoric acid wherein the phosphoric acid is added to the slurry to form a mixture;

reacting the mixture at elevated temperature to form a reaction product; and

separating out an amorphous aluminum phosphate condensate from the reaction product.

~~In a ninth aspect of the present disclosure, there is provided a coating composition comprising:~~

~~an aluminum phosphate pigment having a surface area of less than about 20 m^2/g;~~

~~a pigment material different from the aluminum phosphate; and~~

~~a binding polymer, wherein the aluminum phosphate and pigment material are dispersed within the binding polymer.~~

APs as disclosed herein are made according to a number of different binary condensation techniques. In one example embodiment, APs can be made by a base-to-acid route wherein aluminum hydroxide slurry is added to phosphoric acid in a controlled fashion to form a mixture that undergoes reaction at an elevated temperature

What is Claimed Is:

1. A method for making aluminum phosphate compositions comprising the steps of:

combining ingredients consisting of an aluminum hydroxide slurry formed by combining aluminum hydroxide with water, ~~to form a slurry;~~

~~adding the aluminum hydroxide slurry to~~and phosphoric acid to form a mixture; and

reacting the mixture for a period of time to form a reaction product comprising amorphous aluminum phosphate condensate in the reaction product.

2. The method as recited in claim 1 wherein during the step of reacting the volume of the mixture is maintained at a constant level.

3. The method as recited in claim 1 wherein during the step of reacting moisture is allowed to escape.

4. The method as recited in claim 1 wherein the slurry comprises about 10 to 35 percent by weight aluminum hydroxide.

5. The method as recited in claim 4 wherein the slurry comprises about 25 percent by weight aluminum hydroxide.

6. The method as recited in claim 1 wherein during the step of ~~adding~~combining, the aluminum hydroxide slurry is added to the phosphoric acid in controlled fashion.

7. The method as recited in claim ~~5~~ 6 wherein the slurry is added for a period of about 10 to 60 minutes.

8. The method as recited in claim 1 wherein before the step of ~~adding~~combining, the slurry is heated to an elevated temperature.

9. The method as recited in claim 1 wherein during the step of combining, the water is at an elevated temperature to facilitate dispersion of the aluminum hydroxide to form the slurry.

10. The method as recited in claim 9 wherein the slurry is at an elevated temperature when added to the phosphoric acid.

11. The method as recited in claim 8 wherein the slurry is heated to a temperature of about 30 to 95°C.

12. The method as recited in claim 11 wherein the slurry is heated to a temperature of about 65°C.

13. The method as recited in claim 1 wherein the step of reacting takes place between about 60 to 120°C.

14. The method as recited in claim 13 wherein ~~the elevated temperature is~~ the step of reacting takes place at about 95°C.

15. The method as recited in claim 1 further comprising, after the step of reacting:

separating the amorphous aluminum phosphate condensate from the reaction product; and

drying the condensate to form amorphous aluminum phosphate particles.

16. The method as recited in claim 15 further comprising after the step of separating, heating the amorphous aluminum phosphate condensate to a temperature that is greater than about 200°C to decompose any reaction by-product in the amorphous aluminum phosphate particles.

~~17. The method as recited in claim 1 wherein the aluminum phosphate condensate is amorphous aluminum phosphate.~~

~~18. The method as recited in claim 1 wherein the aluminum phosphate condensate is crystalline aluminum phosphate.~~

~~19. The method as recited in claim 1 wherein the aluminum phosphate condensate is a combination of amorphous aluminum phosphate and crystalline aluminum phosphate.~~

~~20. A chemical composition comprising a binding polymer and the aluminum phosphate prepared according to claim 1.~~

~~21. The chemical composition as recited in claim 20 further comprising a pigment material different from the aluminum phosphate.~~

~~22. The chemical composition as recited in claim 21 wherein the aluminum phosphate comprises less than about 70 percent by weight of the total weight of the pigment materials.~~

~~23~~17. The method as recited in claim 1 wherein particles formed from the aluminum phosphate have an oil absorption of less than about 50.

~~24~~18. The method as recited in claim 1 wherein particles formed from the aluminum phosphate have a surface area of less than about 20 m^2/g.

~~25~~19. A method for making amorphous aluminum phosphate compositions comprising the steps of:

combining ingredients consisting of an aluminum hydroxide slurry formed by combining aluminum hydroxide with water, and ~~to form a slurry; adding the aluminum hydroxide slurry to~~ phosphoric acid to form an acidic aluminum phosphate solution~~;~~ and

combining the acidic aluminum phosphate solution with a further amount of the aluminum hydroxide slurry to form a mixture; and

reacting the mixture for a period of time to form a reaction product comprising amorphous aluminum phosphate condensate in solution.

~~26~~20. The method as recited in claim ~~25~~ 19 wherein during the step of combining the acidic aluminum phosphate solution with aluminum hydroxide slurry there exists a sufficient aluminum content in the mixture to achieve a desired P:Al ratio in the range of from about 0.1 to 1.5 in the condensate made during the step of reacting.

~~27~~21. The method as recited in claim ~~25~~ 19 wherein ~~before the step of adding,~~ the phosphoric acid is diluted with water.

~~28~~22. The method as recited in claim ~~25~~ 19 wherein during the step of reacting, the volume of the mixture is maintained at a constant level.

~~29~~23. The method as recited in claim ~~25~~ 19 wherein the slurry comprises about 10 to 35 percent by weight aluminum hydroxide.

~~30~~24. The method as recited in claim ~~29~~ 23 wherein the slurry comprises about 25 percent by weight aluminum hydroxide.

~~31~~25. The method as recited in claim ~~29~~ 23 wherein the step of reacting takes place at an elevated temperature.

~~32~~26. The method as recited in claim ~~31~~ 25 wherein the elevated temperature is about 95°C.

~~33. The method as recited in claim 25 further comprising before the step of reacting, adding a calcium-containing ingredient to the mixture.~~

~~34~~27. The method as recited in claim ~~25~~ 19 further comprising, after the step of reacting:

separating the aluminum phosphate condensate from the reaction product; and

drying the condensate to form amorphous aluminum phosphate particles.

~~35~~28. The method as recited in claim ~~34~~ 27 further comprising after the step of separating, heating the aluminum phosphate condensate to a temperature that is greater than about 200°C to decompose any reaction by-product in the amorphous aluminum phosphate particles.

~~36~~29. The method as recited in claim ~~25~~ 19 wherein the acidic aluminum phosphate solution is amorphous aluminum phosphate.

~~37. The method as recited in claim 25 wherein the aluminum phosphate condensate is amorphous aluminum phosphate.~~

~~38. The method as recited in in claim 25 wherein the aluminum phosphate condensate is crystalline aluminum phosphate.~~

~~39. The method as recited in claim 25 wherein the aluminum phosphate condensate is a combination of amorphous aluminum phosphate and crystalline aluminum phosphate.~~

~~40~~30. The method as recited in claim ~~25~~ 19 wherein particles formed from the aluminum phosphate have an oil absorption of less than about 50, and a surface area of less than about 20 m^2/g.

~~41. A chemical composition comprising a binding polymer and the aluminum phosphate prepared according to claim 25.~~

~~42. The chemical composition as recited in claim 41 further comprising a pigment material different from the aluminum phosphate.~~

~~43. The chemical composition as recited in claim 42 wherein the aluminum phosphate comprises less than about 70 percent by weight of the total weight of the pigment materials.~~

~~44~~31. The method as recited in claim ~~25~~ 19 wherein during the step of ~~adding~~combining, the acidic aluminum phosphate solution has greater than a 2:1 molar ratio of P:A1. ~~Ray – this is now a dependent claim.~~

~~45~~32. The method as recited in claim ~~25~~ 19 wherein during the reacting step the volume of the mixture is variable.

~~46~~33. A method for making aluminum phosphate comprising the steps of:

combining ingredients consisting of an aluminum hydroxide slurry formed by combining aluminum hydroxide with water, ~~to form a slurry;~~

~~adding the aluminum hydroxide slurry to~~ and phosphoric acid to form a mixture; and

reacting the mixture for a period of time to form a reaction product comprising amorphous aluminum phosphate condensate in solution, wherein during the step of reacting the volume of the mixture is variable.

~~47~~34. The method as recited in claim ~~46~~ 33 wherein during the step of reacting, water from the mixture is evaporated, and water is added to the reaction product.

~~48~~35. The method as recited in claim ~~47~~ 34 wherein during the step of reacting, the water is added to the reaction product in cycles.

~~49~~36. The method as recited in claim ~~47~~ 33 wherein the step of reacting takes place at an elevated temperature between about 60 and 120°C.

~~50~~37. The method as recited in claim ~~49~~ 36 wherein the ~~elevated temperature is~~step of reacting takes place at about 95°C.

~~51~~38. The method as recited in claim ~~47~~ 33 wherein the slurry comprises about 25 percent by weight aluminum hydroxide.

~~52~~39. The method as recited in claim ~~47~~ 33 wherein during the step of ~~adding~~combining, the aluminum hydroxide slurry is added to the phosphoric acid in a controlled fashion.

~~53~~40. The method as recited in claim ~~52~~ 39 wherein the slurry is added for a period of about 10 minutes.

~~54~~41. The method as recited in claim ~~47~~ 33 wherein during the step of reacting, amorphous aluminum phosphate particles are formed and further amorphous aluminum phosphate is disposed onto the already formed amorphous aluminum phosphate particles.

~~55. Aluminum phosphate formed according to the method of claim 54 comprising aluminum phosphate particles that are coated with further aluminum phosphate particles.~~

~~56~~42. The method as recited in claim ~~47~~ 33 further comprising, after the step of reacting:

separating the reaction product to isolate the amorphous aluminum phosphate condensate; and

drying the condensate to form amorphous aluminum phosphate particles.

~~57~~43. The method as recited in claim ~~56~~ 42 further comprising after the step of separating, heating the amorphous aluminum phosphate condensate to a temperature that is greater than about 200°C to decompose any reaction by-product in the amorphous aluminum phosphate particles.

~~58. The method as recited in claim 47 wherein the aluminum phosphate condensate comprises amorphous aluminum phosphate.~~

~~59. The method as recited in claim 47 wherein the aluminum phosphate condensate comprises crystalline aluminum phosphate.~~

~~60. The method as recited in claim 47 wherein the aluminum phosphate condensate comprises a combination of amorphous aluminum phosphate and crystalline aluminum phosphate.~~

~~61~~44. The method as recited in claim ~~47~~ 33 wherein particles formed from the aluminum phosphate have an oil absorption of less than about 50, and a surface area of less than about 20 m^2/g.

~~62. A chemical composition comprising a binding polymer and the amorphous aluminum phosphate prepared according to claim 47.~~

~~63. The chemical composition as recited in claim 62 further comprising a pigment material different from the aluminum phosphate.~~

~~64. The chemical composition as recited in claim 63 wherein the aluminum phosphate comprises less than about 70 percent by weight of the total weight of the pigment materials.~~

~~65~~45. A method for making aluminum phosphate ~~compositions~~ comprising the steps of

combining ingredients consisting of an aluminum hydroxide slurry formed by combining aluminum hydroxide with water, ~~to form a slurry,~~

~~adding to the slurry~~ and phosphoric acid wherein the phosphoric acid is added to the slurry to form a mixture;

reacting the mixture at elevated temperature to form a reaction product; and

separating out an amorphous aluminum phosphate condensate from the reaction product.

~~66~~46. The method as recited in claim ~~65~~ 45 further comprising the step of drying the amorphous aluminum phosphate condensate to form amorphous aluminum phosphate particles.

~~67~~47. The method as recited in claim ~~65~~ 45 wherein the step of reacting takes place in a closed system for about 3 to 48 hours.

~~68~~48 The method in claim ~~65~~ 45 wherein ~~the~~ during the step of reacting the system is open, moisture is allowed to escape, and water is added.

~~69. The method as recited in claim 65 wherein the aluminum phosphate condensate is amorphous.~~

~~70. The method as recited in claim 65 wherein the aluminum phosphate condensate is crystalline.~~

~~71. The method as recited in claim 65 wherein the aluminum phosphate condensate is a mixture of amorphous and crystalline.~~

~~72. A coating composition comprising;~~

~~an aluminum phosphate pigment having a surface area of less than about 20 m^2/g;~~

~~a pigment material different from the aluminum phosphate; and~~

~~a binding polymer, wherein the aluminum phosphate and pigment material are dispersed within the binding polymer.~~

~~73. The coating composition as recited in claim 72 wherein the aluminum phosphate pigment has an oil absorption of less than about 50.~~

~~74. The coating composition as recited in claim 72 wherein the aluminum phosphate is amorphous aluminum phosphate.~~

~~75. The coating composition as recited in claim 72 wherein the aluminum phosphate is crystalline aluminum phosphate.~~

76. The coating composition as recited in claim 72 wherein the aluminum phosphate is a combination of amorphous aluminum phosphate and crystalline aluminum phosphate.

77. The coating composition as recited in claim 72 wherein the aluminum phosphate comprises less than about 70 percent by weight of the total weight of the pigment material.

78. The coating composition as recited in claim 72 wherein the aluminum phosphate comprises a material microstructure of aluminum phosphate particles disposed on aluminum phosphate particles.