conventional ink where the coloring agent would instead be a pigment or a dye. While the use of metal inks can reduce the wastage inherent to foil printing, it results in different drawbacks. There have been reports that printing methods making use of this alternative, did not, for example, achieve the print quality affordable from foil printing.

The Applicant has recognized the need for improved printing methods and systems that are more cost effective and environmentally friendly, yet produce quality print constructions.

SUMMARY

The Applicant has invented a novel printing method described in more details in a co-pending application. The present disclosure is concerned by the print constructions that may be obtained by the method, which is therefore briefly introduced herein to facilitate an understanding of the present teachings.

According to an aspect of the present invention, there is provided a print construction comprising:

(a) a printing substrate having an image-receiving surface;

(b) a receptive layer, at least partially covering said image-receiving surface, and having a particle reception surface distally disposed to said image-receiving surface, said receptive layer optionally having a thickness of at least 1000 nanometer (nm); and

(c) a plurality of individual particles adhered to said particle reception surface, and forming a monolayer thereon;

wherein a number-averaged aspect ratio (**ASPavg**) of said plurality of particles is defined by:

ASPavg = Lavg/Havg

wherein **Lavg** is a number-averaged maximum long dimension of said plurality of particles;

wherein **Havg** is a number-averaged maximum thickness of said plurality of particles; and

wherein said plurality of particles exhibit at least one of the following structural properties:

(A) said number-averaged maximum long dimension (**Lavg**) is at most 800 micrometers;

(B) said number-averaged maximum average thickness (**Havg**) is at most 1200nm;

(C) said number-averaged aspect ratio (**ASPavg**) is at least 1.5:1; and

wherein said monolayer has an optical surface coverage ratio of at least 20%, at least 50%, at least 60%, at least 70%, at least 80%, or at least 90%,

and wherein an outer surface of said particles is hydrophobic.

The printing method comprises providing a donor surface, coating the donor surface with individual particles (*e.g.*, at a coating station), and repeatedly performing the steps of: (i) treating the substrate surface (*e.g.*, at a treating station) to render the affinity of the particles to at least selected regions of the substrate surface greater than the affinity of the particles to the donor surface, (ii) pressing the substrate surface against the donor surface (*e.g.*, at an impression station) to cause a monolayer of particles to transfer from regions of the donor surface only to the selected regions of the substrate surface (thus creating exposed regions of the donor surface in regions corresponding to the selected regions), and (iii) recoating the donor surface with a fresh layer of particles so that only the regions of the donor surface exposed by the transfer of the particles from the donor surface to the substrate in step (ii) are replenished to permit printing of a subsequent image on a substrate surface.

The donor surface coated with particles is used in a manner analogous to the foil used in foil imaging. However, unlike foil imaging, the damage caused to the continuity of the particle layer on the donor surface by each impression can be repaired by re-coating only the exposed regions of the donor surface from which the previously applied layer has been stripped by transfer to the selected regions of the substrate.

The reason that the particle layer on the donor surface can be repaired after each impression is that the particles are selected to adhere to the donor surface more strongly than they do to one another. This results in the applied layer being substantially a monolayer of individual particles. The term “monolayer”, defined more rigorously herein-below, is used herein to describe a layer in which - ideally - each particle has at least a portion that is in direct

CLAIMS

1. A print construction comprising:

(a) a printing substrate having an image-receiving surface;

(b) a receptive layer, at least partially covering said image-receiving surface, and having a particle reception surface distally disposed to said image-receiving surface, said receptive layer optionally having a thickness of at least 1000 nanometer (nm); and

(c) a plurality of individual particles adhered to said particle reception surface, and forming a monolayer thereon;

wherein a number-averaged aspect ratio (**ASPavg**) of said plurality of particles is defined by:

ASPavg = Lavg/Havg

wherein **Lavg** is a number-averaged maximum long dimension of said plurality of particles;

wherein **Havg** is a number-averaged maximum thickness of said plurality of particles;

and wherein said plurality of particles exhibit at least one of the following structural properties:

(A) said number-averaged maximum long dimension (**Lavg**) is at most 800 micrometers;

(B) said number-averaged maximum average thickness (**Havg**) is at most 1200nm;

(C) said number-averaged aspect ratio (**ASPavg**) is at least 1.5:1;

wherein said monolayer has an optical surface coverage ratio of at least 20%, at least 50%, at least 60%, at least 70%, at least 80%, or at least 90%,

and wherein an outer surface of said particles is hydrophobic.

2. The print construction of claim 1, wherein said monolayer is devoid or substantially devoid of a binder such as a polymeric binder.

3. The print construction of claim 1, wherein said monolayer contains, by weight or by volume, at most 20%, at most 15%, at most 10%, at most 5%, binder, at most 3%, or at most 2% of a binder such as a polymeric binder.

4. The print construction of any one of claim 1 to claim 3, wherein said thickness of said receptive layer is at least 1.2 micrometers, at least 1.5 μm, at least 2 μm, at least 3 μm, at least 5 μm, at least 10 μm, at least 20 μm, at least 30 μm, or at least 50 μm.

5. The print construction of any one of claim 1 to claim 4, wherein said average maximum long dimension (**Lavg**) is at most 600 micrometers, at most 400 μm, at most 250 μm, at most 150 μm, at most 100 μm, at most 80 μm, at most 60 μm, at most 40 μm, at most 25 μm, at most 20 μm, at most 15 μm, at most 12 μm, at most 10 μm, at most 8 μm, at most 6 μm, at most 4 μm, at most 3 μm, at most 2 μm, at most 1.5 μm, at most 1.2 μm, at most 1.0 μm, at most 0.8 μm, at most 0.7 μm, at most 0.65 μm, or at most 0.6 μm.

6. The print construction of any one of claim 1 to claim 5, wherein said maximum average thickness (**Havg**) is at most 1000 nm, at most 800 nm, at most 600 nm, at most 500 nm, at most 400 nm, at most 350 nm, at most 300 nm, at most 250 nm, at most 200 nm, at most 175 nm, at most 150 nm, at most 125 nm, at most 100 nm or at most 80 nm.

7. The print construction of any one of claim 1 to claim 6, wherein said maximum average thickness (**Havg**) is at least 5 nm, at least 7 nm, at least 10 nm, at least 15 nm, at least 20 nm, at least 25 nm, at least 30 nm, at least 40 nm, or at least 50 nm.

8. The print construction of any one of claim 1 to claim 7, wherein said average aspect ratio (**ASPavg**) is at least 1.5:1, at least 1.75:1, at least 2:1, at least 2.5:1, at least 3:1, at least 4:1, at least 5:1, or at least 6:1.

9. The print construction of any one of claim 1 to claim 8, wherein said average aspect ratio (**ASPavg**) is at least 8:1, at least 10:1, at least 15:1, or at least 20:1, at least 25:1, or at least 30:1.

10. The print construction of any one of claim 1 to claim 9, wherein said average aspect ratio (**ASPavg**) of said plurality of particles is at most 100:1, at most 75:1, at most 60:1, at most 50:1, or at most 45:1.

11. The print construction of any one of claim 1 to claim 10, wherein said average aspect ratio (**ASPavg**) is at most 40:1, at most 35:1, at most 30:1, at most 25:1, at most 20:1, at most 15:1, at most 12:1, at most 10:1, or at most 7:1.

12. The print construction of any one of claim 1 to claim 7, wherein said average aspect ratio (**ASPavg**) is within a range of 1.5:1 to 50:1, 1.5:1 to 30:1, 1.5:1 to 20:1, 1.5:1 to 15:1, 1.5:1 to 10:1, 1.5:1 to 8:1, or 1.5:1 to 6:1.

13. The print construction of claim 12, wherein said average aspect ratio (**ASPavg**) is at least 2:1, at least 2.25:1, at least 2.5:1, at least 3:1, at least 3.5:1, or at least 4:1.

14. The print construction of any one of claim 1 to claim 10, wherein said particles are non-hydrophobic, and wherein a hydrophobic layer is attached to a surface of each of said particles, and at least partially envelops, each of said particles.

15. The print construction of claim 14, wherein said hydrophobic layer is an inorganic hydrophobic layer optionally including an oxide.

16. The print construction of claim 14, wherein said hydrophobic layer is an organic hydrophobic layer.

17. The print construction of claim 16, wherein said organic hydrophobic layer includes, mainly includes, or consists essentially of at least one of the group consisting of a fatty acid, an oil and an oily substance.

18. The print construction of claim 17, wherein said fatty acid, said oil, and said oily substance have a backbone having a carbon number of at least 6, and optionally, within a range of 6 to 50, 6 to 30, 6 to 24 or 10 to 24.

19. The print construction of any one of claim 14 to claim 18, wherein said hydrophobic layer has a thickness of at most 15 nm, at most 10 nm, at most 7 nm, at most 5 nm, at most 4 nm, at most 3 nm, at most 2.5 nm, or at most 2 nm.

20. The print construction of any one of claim 1 to claim 17, wherein an organic content of said particles, by weight, is at most 15%, at most 12%, at most 10%, at most 8%, at most 6%, or at most 4%.

21. The print construction of any one of claim 1 to claim 20, wherein said monolayer includes a plurality of particles not adhered or affixed to said particle reception surface, said monolayer having at most 35%, at most 30%, at most 25%, at most 20%, at most 15%, at most 10%, at most 7%, at most 5%, at most 3%, or at most 2%, by number, of said particles.

22. The print construction of any one of claim 1 to claim 21, wherein said monolayer has an optical surface coverage ratio of at least 20%, at least 50%, at least 60%, at least 70%, at least 80%, at least 90%, or at least 95%, and optionally, within a range of 20% to 100%, 40% to 100%, 50% to 100%, 60% to 100%, 80% to 100%, or 80% to 95%.

23. The print construction of any one of claim 1 to claim 22, wherein said receptive layer has a first or upper half ending at said particle reception surface, and a second or lower half disposed towards and contacting said image-receiving surface, and wherein at most 5%, at most 3%, at most 1%, or substantially none of said plurality of individual particles are disposed within or at least partially within said lower half of said receptive layer.

24. The print construction of any one of claim 1 to claim 22, wherein within a field of view containing at least 5, at least 10, at least 15, at least 20, or at least 35 particles of said plurality of particles, said receptive layer has a first or upper half ending at said particle reception surface, and a second or lower half disposed towards and contacting said image-receiving surface, and wherein at most 5%, at most 3%, at most 1%, or substantially none of said plurality of individual particles are disposed within or at least partially within said lower half of said receptive layer.

25. The print construction of any one of claim 1 to claim 24, wherein at least one of said particles within said monolayer is an overlapping particle that overlaps or at least partially overlaps an underlying particle of said particles, and wherein a minimum distance between said overlapping particle and a surface of said underlying particle proximate to said overlapping particle is at most 25 nm, at most 20 nm, at most 15 nm, at most 10 nm, at most 8 nm, at most 6 nm, or at most 4 nm.

26. The print construction of any one of claim 1 to claim 24, wherein, within a field of view containing at least 5, at least 10, at least 15, at least 20, or at least 35 particles of said plurality of particles, at least one of said particles within said monolayer is an overlapping particle that overlaps or at least partially overlaps a respective underlying particle of said particles, and wherein a minimum distance between each said overlapping particle and a surface of said respective underlying particle proximate to said overlapping particle is at most 25 nm, at most 20 nm, at most 15 nm, at most 10 nm, at most 8 nm, at most 6 nm, or at most 4 nm.

27. The print construction of any one of claim 1 to claim 24, further comprising an overcoat layer covering said monolayer, said overcoat layer optionally having a

thickness of at least 1.5 micrometers, at least 2 μm, at least 3 μm, at least 5 μm, at least 10 μm, at least 20 μm, at least 30 μm, or at least 50 μm, said thickness of said overcoat layer optionally being at most 300 micrometers, at most 250 μm, at most 200 μm, at most 150 μm, or at most 100 μm.

28. The print construction of claim 27, wherein said overcoat layer has a first or upper half extending away from said receptive layer, and a second or lower half disposed towards said receptive layer, and wherein at most 5%, at most 3%, at most 1%, or substantially none of said plurality of individual particles are disposed within or at least partially within said upper half of said overcoat layer.

29. The print construction of claim 27, wherein, within a field of view containing at least 5, at least 10, at least 15, at least 20, or at least 35 particles of said plurality of particles, said overcoat layer has a first or upper half extending away from said receptive layer, and a second or lower half disposed towards and optionally contacting said receptive layer, and wherein at most 5%, at most 3%, at most 1%, or substantially none of said plurality of individual particles are disposed within or at least partially within said upper half of said overcoat layer.

30. The print construction of any one of claim 27 to claim 29, wherein said overcoat is a colored or uncolored transparent, translucent, or opaque coating.

31. The print construction of any one of claim 1 to claim 30, wherein said receptive layer is disposed on solely a portion of said image-receiving surface.

32. The print construction of claim 31, wherein said monolayer is disposed solely on said portion of said image-receiving surface upon which said receptive layer is disposed.

33. The print construction of any one of claim 1 to claim 32, said printing substrate selected from the group consisting of fibrous printing substrates and plastic printing substrates.

34. The print construction of any one of claim 1 to claim 33, said printing substrate having a thickness of at least 10 micrometers, at least 20 μm, at least 30 μm, or at least 40 μm.

35. The print construction of any one of claim 1 to claim 34, wherein at least 10%, at least 25%, at least 50%, at least 75%, at least 90%, by number, or substantially all of said particles, are metallic or metal-looking particles.

36. The print construction of claim 35, wherein said metallic particles are selected from at least one of the group consisting of aluminum, copper, iron, zinc, nickel, tin, titanium, gold, silver, and alloys thereof.

37. The print construction of claim 36, wherein said alloys include at least one of steel, bronze and brass.

38. The print construction of claim 35, wherein said metallic particles include, mainly include, predominantly include, or consist essentially of platelets having a planar dimension whose orientation is in a direction substantially parallel to the image-receiving surface.

39. The print construction of claim 38, said platelets having a light reflective surface so as to provide for a glossy image.

40. The print construction of claim 39, wherein the glossy image has a gloss per size (GPS) of at least 100 Gloss Units (GU) per average maximum long dimension (**Lavg**) of the particles, said dimension being in micrometers.