LIQUID COATING METHOD AND APPARATUS WITH A DEFORMABLE METAL ROLL

TECHNICAL FIELD

The present disclosure relates to methods and apparatus of applying a liquid coating to a substrate by using a deformable roll including a thin metal shell.

BACKGROUND

Numerous industrial and consumer products include an aspect of coating in their manufacture in which one or more layers of liquid material are deposited onto a discrete object or onto a thin web of material of indefinite length being conveyed through a web path. It is frequently desirable to convey such a web at as great a speed as practicable through the web path in order to minimize the cost of production.

SUMMARY

Briefly, the disclosure describes a method including providing a first roll, a second roll, and a nip formed between the first and second rolls, supplying a coating liquid to the nip, and smoothing the coating liquid, via the nip, into a substantially uniform layer of liquid coating. The second roll includes a thin metal shell and a resilient layer, the thin metal shell encases the resilient layer therebeneath, and the thin metal shell is capable of deflecting in unison with the resilient layer such that the thin metal shell is elastically deformable at the nip when in contact with the first roll. The layer of liquid coating is transferred to a substrate. In some embodiments, the liquid coating is applied to a web of indefinite length material.

In one aspect, the present disclosure relates to a method, comprising: providing a first roll, a second roll, and a nip formed between the first and second rolls; supplying a coating liquid to the nip; and smoothing the coating liquid, via the nip, into a substantially uniform layer of liquid coating, wherein the second roll comprises a thin metal shell and a resilient layer, the thin metal shell encases the resilient layer therebeneath, and the thin metal shell is capable of deflecting in unison with the resilient layer such that the thin metal shell is elastically deformable at the nip when in contact with the first roll, wherein the layer of liquid coating is transferred to a substrate, and wherein the resilient layer comprises one or more of a rubber, a foam or a patterned elastomer.

This disclosure describes a coating apparatus that includes a second roll including a thin metal shell and a resilient layer. The thin metal shell encases the resilient layer therebeneath, and the thin metal shell is capable of deflecting in unison with the resilient layer. A first roll forms a nip with the second roll such that the thin metal shell is capable of being elastically deformed at the nip when in contact with the first roll. A liquid delivery system is disposed to supply coating liquid into the nip.

In another aspect, the present disclosure relates to a coating apparatus, comprising: a first roll, a second roll comprising a thin metal shell and a resilient layer, the thin metal shell encases the resilient layer therebeneath, and the thin metal shell is capable of deflecting in unison with the resilient layer; the first and second rolls forming a nip such that the thin metal shell is capable of being elastically deformed at the nip by contact with the first roll; and a liquid delivery system disposed to supply coating liquid into the nip, and wherein the resilient layer comprises one or more of a rubber, a foam or a patterned elastomer.

Various unexpected results and advantages are obtained in exemplary embodiments of the disclosure. One such advantage of exemplary embodiments of the present disclosure is that a very thin (e.g., no greater than 5 microns, or even no greater than 2.5 microns), continuous liquid

What is claimed is:

1. A method, comprising:

providing a first roll, a second roll, and a nip formed between the first and second rolls;

supplying a coating liquid to the nip; and

smoothing the coating liquid, via the nip, into a substantially uniform layer of liquid coating,

wherein the second roll comprises a thin metal shell and a resilient layer, the thin metal shell encases the resilient layer therebeneath, and the thin metal shell is capable of deflecting in unison with the resilient layer such that the thin metal shell is elastically deformable at the nip when in contact with the first roll,

wherein the layer of liquid coating is transferred to a substrate, and

wherein the resilient layer comprises one or more of a rubber, a foam or a patterned elastomer.

2. The method of claim 1, wherein the layer of liquid coating on the substrate has a thickness no greater than about 5 microns.

3. The method of claim 1 or 2, wherein the thin metal shell is configured to be removable from the second roll.

4. The method of any one of claims 1-3, wherein the second roll further comprises a rigid central core, and the resilient layer has substantially uniform thickness about the periphery of the rigid central core.

5. The method of any one of claims 1-4, wherein the substrate is a web of indefinite length, and the method further comprises wrapping the web around one of the first and second rolls.

6. The method of any one of claims 1-5, further comprising determining a line speed at which one of the first and second rolls is rotated, the predetermined line speed and the viscosity of the coating liquid are such that a calculated capillary number Ca for the coating is greater than a critical value.

7. The method of claim 6, wherein the critical value of the capillary number Ca is in the range from about 0.1 to about 2, and the capillary number Ca is no greater than 500.

8. The method of any one of claims 1-7, wherein the thin metal shell comprises nickel.

9. The method of any one of claims 1-8, wherein the thin metal shell has a thickness between about 0.1 mm and about 1 mm.

10. The method of any one of claims 1-9, wherein the resilient layer is compressible and capable of preventing slip between the thin metal shell and the resilient layer.

11. A coating apparatus, comprising:

a first roll;

a second roll comprising a thin metal shell and a resilient layer, the thin metal shell encases the resilient layer therebeneath, and the thin metal shell is capable of deflecting in unison with the resilient layer;

the first and second rolls forming a nip such that the thin metal shell is capable of being elastically deformed at the nip by contact with the first roll; and

a liquid delivery system disposed to supply coating liquid into the nip,

wherein the resilient layer comprises one or more of a rubber, a foam or a patterned elastomer.

12. The coating apparatus of claim 11, wherein the thin metal shell is configured to be removable from the layer of resilient material.

13. The coating apparatus of claim 11 or 12, wherein the second roll further comprises a rigid central core, and the resilient layer has substantially uniform thickness about the periphery of the rigid central core.

14. The coating apparatus of any one of claims 11-13, wherein the thin metal shell comprises nickel.

15. The coating apparatus of any one of claims 11-14, wherein the thin metal shell has a thickness between about 0.1 mm and about 1 mm.

16. The coating apparatus of any one of claims 11-15, wherein the ratio between the thickness of the thin metal shell and the diameter of the second roll is between 1:15000 and 1:80.

17. The coating apparatus of any one of claims 11-16, wherein the first roll is a rigid roll.

18. The coating apparatus of any one of claims 11-17, further comprising a rotation mechanism configured to rotate one of the first and second rolls at a predetermined line speed, wherein the predetermined line speed and the viscosity of the coating material are such that a calculated capillary number Ca for the coating is greater than a critical value, and the critical value is about 0.1 or more.

19. The coating apparatus of any one of claims 11-18, wherein the resilient layer is compressible and capable of preventing slip between the thin metal shell and the resilient layer.