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 first 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 second 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 first 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 second roll, and wherein the layer of liquid coating is transferred to a substrate.

This disclosure describes a coating apparatus that includes a first 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 second roll forms a nip with the first roll such that the thin metal shell is capable of being elastically deformed at the nip when in contact with the second 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 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; a second roll forming a nip with the first roll such that the thin metal shell is capable of being elastically deformed at the nip by contact with the second roll; and a liquid delivery system disposed to supply coating liquid into the nip.

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

Embodiment 23 is the coating apparatus of any one of embodiments 16-22, 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.

Embodiment 24 is the coating apparatus of any one of embodiments 16-23, wherein the resilient layer is made of a foam.

Various advantages of exemplary embodiments of the disclosure have been summarized. The above Summary is not intended to describe each illustrated embodiment or every implementation of the present certain exemplary embodiments of the present disclosure. The Drawings and the Detailed Description that follow more particularly exemplify certain preferred embodiments using the principles disclosed herein.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure may be more completely understood in consideration of the following detailed description of various embodiments of the disclosure in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a coating apparatus carrying out a portion of a first embodiment of the disclosure;

FIG. 2 is a cross-section side view through one of the rollers of FIG. 1, taken along section lines 2-2;

FIG. 3 is a photograph of the experiment described in Example 1;

FIG. 4 is a photograph of the experiment described in comparative Example C1;

FIG. 5 is a photograph of the experiment described in Example 2;

FIG. 6 is a photograph of the experiment described in comparative Example C2;

FIG. 7 is a photograph of the experiment described in Example 3; and

FIG. 8 is a photograph of the experiment described in comparative Example C3.

In the drawings, like reference numerals indicate like elements. While the above-identified drawing, which may not be drawn to scale, sets forth various embodiments of the present disclosure, other embodiments are also contemplated, as noted in the Detailed Description. In all cases, this disclosure describes the presently disclosed disclosure by way of representation of exemplary embodiments and not by express limitations. It should be understood that numerous other modifications and embodiments can be devised by those skilled in the art, which fall within the scope and spirit of this disclosure.