LAYER-BY-LAYER COATING APPARATUS AND METHOD

TECHNICAL FIELD

The disclosure relates to an apparatus for layer-by-layer coating as well as methods of layer-by-layer coating.

BACKGROUND

Layer-by-layer (sometimes known as LBL) coating is known in the art, and was traditionally performed by a dip-coating technique wherein a substrate was dipped in a polycation solution to deposit a monolayer of polycation. The substrate was removed from the polycation solution, rinsed to remove excess polycation, dipped into a polyanion solution to deposit a monolayer of polyanion, removed from the polyanion solution, and finally rinsed again to remove excess polyanion. The result of that process was a bilayer deposited on a surface of the substrate. The process could be repeated to obtain the desired number of bilayers.

A variety of substances have been used for the various monolayers of the LBL bilayer. Typically, the two monolayers are chosen so that each of the monolayers binds or adheres only to the other monolayer (and, in the case of the first deposited monolayer, to the substrate) but not to itself.

SUMMARY

An apparatus can comprise a first roller for moving a belt and a second roller for moving a belt. The apparatus can include a belt having a first major surface and a second major surface tensioned around the first roller and the second roller. A first deposition station can be positioned to face belt, the first deposition station comprising a first self-limiting monolayer forming material depositing element for affixing a monolayer of a first self-limiting monolayer forming material to the belt. A first directional gas curtain producing element can be positioned downstream from the first deposition station.

In one aspect, there is provided an apparatus comprising a first roller for moving a belt; a second roller for moving a belt; a belt having tensioned around the first roller and the second roller; a first deposition station positioned to face the belt, the first deposition station comprising a first self-limiting monolayer forming material depositing element for depositing a first liquid comprising a first self-limiting monolayer forming material on the belt and affixing a monolayer of a first self-limiting monolayer forming material to the belt, and a first directional gas curtain producing element positioned downstream from the first deposition station to provide a gas curtain blowing the belt, the first directional gas curtain element being configured and arranged to provide a gas curtain that simultaneously meters and dries a first liquid on the belt while leaving at least the monolayer of first self-limiting monolayer forming material on the belt, and wherein the apparatus does not

include a rinsing element to remove excess first liquid from the belt.

A second deposition station that is different from the first deposition station can optionally be employed in which case it can be positioned to face the outside surface of the belt, the second deposition station comprising a second self-limiting monolayer forming material depositing element for affixing a monolayer of a second self-limiting monolayer forming material to the belt. The second deposition can be downstream of the first deposition station and downstream from the first directional gas curtain producing element. A second directional gas curtain producing element can be positioned downstream from the second deposition station to face the outside of the surface of the belt to provide a gas curtain blowing on the outside surface of the belt.

In another aspect, there is provided a method of making a coating on a substrate, the method comprising (a) tensioning a substrate in the form of a belt around a first roller and a second roller such that at least a portion of the belt faces a first deposition station, the first deposition station comprising a first self-limiting monolayer forming material depositing element for affixing a monolayer of a first self-limiting monolayer forming material to the belt, (b) moving the belt around the first roller and the second roller while engaging the first self-limiting monolayer forming material depositing element to apply a first liquid comprising a first self-limiting monolayer forming material on the belt; (c) engaging a first directional gas curtain producing element that is positioned downstream from the first deposition station to provide a gas curtain that simultaneously meters and dries the first liquid on the belt while leaving at least a monolayer of first self-limiting monolayer forming material on the belt, wherein the method does not include a rinsing step to remove excess first liquid from the belt.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a schematic of an apparatus as described herein;

What is claimed is:

1. An apparatus comprising

a first roller for moving a belt;

a second roller for moving a belt;

a belt having tensioned around the first roller and the second roller;

a first deposition station positioned to face the belt, the first deposition station comprising a first self-limiting monolayer forming material depositing element for depositing a first liquid comprising a first self-limiting monolayer forming material on the belt and affixing a monolayer of the first self-limiting monolayer forming material to the belt; and

a first directional gas curtain producing element positioned downstream from the first deposition station to provide a gas curtain blowing the belt, the first directional gas curtain element being configured and arranged to provide a gas curtain that simultaneously meters and dries the first liquid on the belt while leaving at least the monolayer of first self-limiting monolayer forming material on the belt, and wherein the apparatus does not include a rinsing element to remove excess first liquid from the belt.

2. The apparatus of claim 1, further comprising

a second deposition station located downstream of the first directional gas curtain producing element, the second deposition station comprising a second self-limiting monolayer forming material depositing element for affixing a monolayer of a second self-limiting monolayer forming material to the belt; and

a second directional gas curtain producing element a positioned downstream from the second deposition station to provide a gas curtain blowing on the belt.

3. The apparatus of any of the preceding claims, wherein
the first self-limiting monolayer forming material is a component of a first liquid; and
wherein the apparatus further comprises

a first recycling element for collecting at least some of the first liquid and returning at least some of the collected first liquid to the first deposition station.

4. The apparatus of any of claims 2-3, wherein

the second self-limiting monolayer forming materials is a component of a second liquid; and
wherein the apparatus further comprises

a second recycling element for collecting at least some of the second liquid and returning at least some of the collected second liquid to the second deposition station.

5. The apparatus of any of claims 2-4, wherein at least one of the first self-limiting monolayer forming material depositing element and the second self-limiting monolayer forming material depositing element is a sprayer.

6. The apparatus of any of the preceding claims, wherein the apparatus is capable of affixing a monolayer of cationic material or anionic material to the belt while the belt is moving at a speed of at least 0.25 m/s.

7. A method of making a coating on a substrate, the method comprising

(a) tensioning a substrate in the form of a belt around a first roller and a second roller such that at least a portion of the belt faces a first deposition station,

the first deposition station comprising

a first self-limiting monolayer forming material depositing element

for affixing a monolayer of a first self-limiting monolayer forming material to the belt,

(b) moving the belt around the first roller and the second roller while engaging the first self-limiting monolayer forming material depositing element to apply a first liquid comprising a first self-limiting monolayer forming material on the belt;

(c) engaging a first directional gas curtain producing element that is positioned downstream from the first deposition station to provide a gas curtain that simultaneously meters and dries the first liquid on the belt while leaving at least a monolayer of first self-limiting monolayer forming material on the belt, wherein the method does not include a rinsing step to remove excess first liquid from the belt.

8. The method of claim 7, wherein the step of applying a first liquid comprising a first self-limiting monolayer forming material on the belt comprises spraying the first liquid on the belt.

9. The method of any of claims 7-8, wherein at least a portion of the belt faces a second deposition station that is downstream from the first deposition station,

the second deposition station comprising

a second self-limiting monolayer forming material depositing element for affixing at least a monolayer of a second self-limiting monolayer forming material to the belt; and wherein

the method further comprises the step of

(d) engaging the second self-limiting monolayer forming material depositing element to apply a second liquid comprising the second self-limiting monolayer forming material on the belt; and

(e) engaging a second directional gas curtain producing element that is positioned downstream from the second deposition station to provide a gas curtain that simultaneously meters and dries the first liquid on the belt while leaving at least a monolayer of first self-limiting monolayer forming material on the belt.

10. The method of any of claims 7-9, wherein the belt does not stop moving until at least one of a pre-determined number of monolayers are deposited, a pre-determined amount of time passes, a pre-determined thickness is achieved, or a pre-determined optical, chemical, or physical property is achieved.

11. The method of claim 9, wherein the first and second self-limiting monolayer forming materials are applied to the belt by sprayers.

12. The method of any of claims 7-11, wherein the method is a roll-to-roll process.