DUAL-SIDED STRUCTURED FILM ARTICLES

Field of the Disclosure

This disclosure relates generally to film articles with dual-sided structures, and methods for preparing them.

Background

A wide range of articles, such as films, sheets and the like have two major surfaces. It is often desirable in the fabrication of such articles to be able to produce a structured surface on both of the major surfaces. Various techniques have been developed for producing a structured surface on both major surfaces of an article.

In US Patent No. 7,165,959 (Humlicek et al.) an apparatus is described for casting a patterned surface on both sides of a web. The apparatus includes two patterned rolls maintained in continuous registration to within at least 100 microns. Similarly, US Patent No. 7,484,950 (Mizunuma et al.) describes an alignment device for forming double-surface formed sheets. In this device a first forming roll and a second forming roll are provided parallel and opposite to each other, and control devices are provided that reduce the phase difference between the forming shapes on the two surfaces.

US Patent Publication 2012/0156777 (Rangarajan et al.) describes a carrier for growing adherent cells which comprises one or more outer surfaces and one or more structured indentations on one or more of the outer surfaces.

Summary

Described herein are film articles that are structured substrates with dual-sided structures, and methods for preparing them. Structured substrates with dual-sided structures are ones in which both of the major surfaces of the substrate have a structured surface, generally a microstructured surface.

In some embodiments, the structured substrate comprises a first major surface and second major surface, where the first major surface and the second major surface each comprise a plurality of spaced apart protrusions forming a repeating microstructured pattern. Each repeating microstructured pattern has a major axis, where the major axis comprises one of the major axes in the translational direction of the repeating microstructured pattern. The major axis of the repeating microstructured

pattern on the second major surface forms an oblique angle with the major axis on the first major surface, where the angle is in the range of 10-90% of the angle of rotational symmetry of the repeating microstructured pattern. The structured substrate is a unitary substrate. In some embodiments, the repeating microstructured pattern on the first major surface and/or the second major surface comprises a periodic geometric pattern.

Also disclosed herein are methods for preparing structured articles with dual-sided structures. In some embodiments, the method of preparing an article comprises providing a flowable material composition having a first major surface and second major surface, providing a first microstructuring tool, the first microstructuring tool comprising a structured surface comprising a pattern comprising a plurality of depressions, providing a second microstructuring tool, the second microstructuring tool comprising a structured surface comprising a pattern comprising a plurality of depressions, and simultaneously contacting the first microstructuring tool to the first major surface of the flowable material composition and contacting the second microstructuring tool to the second major surface of the flowable material composition to form structured first and second major surfaces on the flowable material composition. The structured first major surface and the structured second major surface each comprise a plurality of spaced apart protrusions forming a repeating pattern, each repeating pattern having a major axis. The major axis comprises one of the major axes in the translational direction of the repeating pattern. The major axis of the repeating pattern on the second major surface forms an oblique angle with the major axis on the first major surface. The angle is in the range of 10-90% of the angle of rotational symmetry of the repeating pattern.

Brief Description of the Drawings

The present application may be more completely understood in consideration of the following detailed description of various embodiments of the disclosure in connection with the accompanying drawings.

Figure 1 shows a schematic of a process of this disclosure for forming a dual-sided structured article.

What is claimed is:

1. A structured substrate comprising:
a first major surface and second major surface, wherein the first major surface and the second major surface each comprise a plurality of spaced apart protrusions forming a repeating microstructured pattern, each repeating microstructured pattern having a major axis, wherein the major axis comprises one of the major axes in the translational direction of the repeating mircrostructured pattern, and wherein the major axis of the repeating microstructured pattern on the second major surface forms an oblique angle with the major axis on the first major surface, wherein the angle is in the range of 10-90% of the angle of rotational symmetry of the repeating microstructured pattern, and wherein the structured substrate is a unitary substrate.

2. The structured substrate of claim 1, wherein the repeating microstructured pattern on the first major surface and/or the second major surface comprise any periodic geometric pattern.

3. The structured substrate of claim 2, wherein the periodic geometric pattern comprises a pattern of squares, a pattern of hexagons, a pattern of triangles, or a pattern of circles.

4. The structured substrate of claim 1, wherein the repeating microstructured pattern on the first major surface is the same as the repeating microstructured pattern on the second major surface.

5. The structured substrate of claim 1, wherein the angle is in the range of 20-80% of the angle of rotational symmetry of the repeating microstructured pattern.

6. The structured substrate of claim 1, wherein the repeating microstructured pattern on the first major surface and the repeating microstructured pattern on the second major surface form an array of cavities, and wherein the protrusions form the walls of the cavities.

7. The structured substrate of claim 6, wherein the array of cavities comprises an array of square cavities.

8. The structured substrate of claim 6, wherein the array of cavities comprises an array of hexagonal cavities.

9. The structured substrate of claim 6, wherein the array of cavities comprises an array of triangular cavities.

10. The structured substrate of claim 6, wherein the array of cavities comprises an array of circular cavities.

11. The structured substrate of claim 6, wherein in a cross sectional view along the major axis on the first major surface, a first surface area is defined as the region of the first major surface comprising a protrusion and the cavity for which the protrusion forms one wall, a second surface area is defined as the region of the second major surface comprising a protrusion and the cavity for which the protrusion forms one wall, and a third surface area is defined as the land area between the first surface area and the second surface area, and wherein the ratio of the sum of the first surface area and the second surface area to the third surface area is 1:1 or greater.

12. The structured substrate of claim 1 being made by extrusion replication.

13. The structured substrate of claim 1, wherein the structured substrate comprises a uniform material composition.

14. A method of preparing an article comprising:

providing a flowable material composition comprising a first major surface and second major surface;

providing a first microstructuring tool, the first microstructuring tool comprising a structured surface comprising a pattern comprising a plurality of depressions;

providing a second microstructuring tool, the second microstructuring tool comprising

a structured surface comprising a pattern comprising a plurality of depressions; and

simultaneously contacting the first microstructuring tool to the first major surface of the flowable material composition and contacting the second microstructuring tool to the second major surface of the flowable material composition to form structured first and second major surfaces on the flowable material composition, wherein the structured first major surface and the structured second major surface each comprise a plurality of spaced apart protrusions forming a repeating pattern, each repeating pattern having a major axis, wherein the major axis comprises one of the major axes in the translational direction of the repeating pattern, and wherein the major axis of the repeating pattern on the second major surface forms an oblique angle with the major axis on the first major surface, wherein the angle is in the range of 10-90% of the angle of rotational symmetry of the repeating pattern.

15. The method of claim 14, wherein the flowable material composition comprises a unitary film.

16. The method of claim 15, wherein unitary film comprises a monolithic construction.

17. The method of claim 15, wherein the unitary film comprises a multi-layer construction.

18. The method of claim 14, wherein providing the flowable material composition comprises extrusion of a unitary film.

19. The method of claim 18, wherein extrusion comprises co-extrusion.

20. The method of claim 15, wherein the unitary film, prior to structuring, has a thickness of from 25-203 micrometers.

21. The method of claim 14, wherein each of the first and second structured surfaces comprises a plurality of parallel spaced apart ridges extending along a first direction intersecting a plurality of parallel spaced apart ridges extending along a second direction perpendicular to the first direction to form an array of cavities, each cavity being defined by four walls, the walls of the cavities on the first and second structured surfaces having a same height and width, the first direction in the first major surface forming an oblique angle in a range from 20° to 70° with the first direction in the second major surface.

22. The method of claim 21, wherein the array of cavities comprises a square array of cavities.

23. The method of claim 21, wherein the cavities in the first and second major surfaces are separated by a land having a land thickness of from 25-203 micrometers.