LUMINAIRE FOR CROSSWALK

Background

The potential for greatest vehicle safety advancements are in emerging economies, and in particular rural areas of developed countries. Reduced visibility at night is a key contributor to pedestrian fatalities due to vehicle/pedestrian collisions. It is desired to improve the illumination of pedestrians in crosswalks while preventing excessive glare that may endanger both drivers and pedestrians.

Summary

The present disclosure describes light delivery and distribution components of a light duct that can be used as a luminaire, such as a bollard-style luminaire that can be useful for the illumination of pedestrian crosswalks. The bollard luminaire includes a design that generally confines light to illuminate the crosswalk and the pedestrian in the crosswalk, such that light that could produce glare for the pedestrian and/or a driver approaching the crosswalk is minimized. The delivery and distribution system (i.e., light duct and light duct extractor) can function effectively with any light source that is capable of delivering light which is substantially collimated about the longitudinal axis of the light duct, and which is also preferably substantially uniform over the inlet of the light duct.

In one aspect, the present disclosure provides a luminaire that includes a light duct having a longitudinal axis, light input end, an opposing end, and a reflective interior surface surrounding a cavity; a light output region including a plurality of voids disposed in the reflective interior surface, whereby light can exit the cavity; and an asymmetric turning film. The asymmetric turning film includes a first surface including parallel prismatic microstructures, each having a vertex adjacent the light output region and aligned perpendicular to the longitudinal axis; and an opposing second planar surface, wherein each vertex includes a prism angle having a bisector that is perpendicular to the longitudinal axis and the opposing second planar surface, the bisector dividing the prism angle into a first vertex angle proximate the light input end and a different second vertex angle proximate the opposing end. The first vertex angle is larger than the second vertex angle.

In another aspect, the present disclosure provides a luminaire that includes a light duct having a longitudinal axis, light input end, an opposing end, and a reflective interior surface surrounding a cavity; a light output region including a plurality of voids disposed in the reflective interior surface, whereby light can exit the cavity; an asymmetric turning film; and a light source disposed to inject a light beam into the light duct through the light input end. The asymmetric turning film includes a first surface including parallel prismatic microstructures, each having a vertex adjacent the light output region and aligned perpendicular to the longitudinal axis; and an opposing second planar surface, wherein each vertex includes a prism angle having a bisector that is perpendicular to the longitudinal axis and the

opposing second planar surface, the bisector dividing the prism angle into a first vertex angle proximate the light input end and a different second vertex angle proximate the opposing end. The first vertex angle is larger than the second vertex angle.

Disclosed herein is a method of illuminating a pedestrian cross-walk that includes positioning at least one luminaire on a roadway adjacent a pedestrian cross-walk. The luminaire includes a light duct having a longitudinal axis, light input end, an opposing end, and a reflective interior surface surrounding a cavity; a light output region including a plurality of voids disposed in the reflective interior surface, whereby light can exit the cavity; an asymmetric turning film; and a light source disposed to inject a light beam into the light duct through the light input end. The asymmetric turning film includes a first surface including parallel prismatic microstructures, each having a vertex adjacent the light output region and aligned perpendicular to the longitudinal axis; and an opposing second planar surface, wherein each vertex includes a prism angle having a bisector that is perpendicular to the longitudinal axis and the opposing second planar surface, the bisector dividing the prism angle into a first vertex angle proximate the light input end and a different second vertex angle proximate the opposing end. The luminaire is positioned adjacent the cross-walk such that the longitudinal axis is positioned vertically The method of illuminating a pedestrian cross-walk further includes energizing the light source such that the cross-walk is illuminated while reducing illumination of surrounding areas.

The above summary is not intended to describe each disclosed embodiment or every implementation of the present disclosure. The figures and the detailed description below more particularly exemplify illustrative embodiments.

Brief Description of the Drawings

Throughout the specification reference is made to the appended drawings, where like reference numerals designate like elements, and wherein:

FIG. 1 shows a perspective schematic view of an illuminated pedestrian crosswalk;

FIG. 2A shows an exploded perspective schematic view of a lighting element;

FIG. 2B shows a perspective schematic view of a lighting element;

FIG. 2C shows a schematic cross sectional side view of a portion of a lighting element;

FIG. 2D shows a cross-sectional schematic side view of a luminaire;

FIG. 2E shows a cross-sectional schematic side view of a luminaire; and

FIG. 2F shows a cross-sectional schematic view of a luminaire.

The figures are not necessarily to scale. Like numbers used in the figures refer to like components. However, it will be understood that the use of a number to refer to a component in a given figure is not intended to limit the component in another figure labeled with the same number.

CLAIMS

1. A luminaire, comprising:

a light duct having a longitudinal axis, light input end, an opposing end, and a reflective interior surface surrounding a cavity;

a light output region including a plurality of voids disposed in the reflective interior surface, whereby light can exit the cavity;

an asymmetric turning film, comprising:

a first surface including parallel prismatic microstructures, each having a vertex adjacent the light output region and aligned perpendicular to the longitudinal axis; and

an opposing second planar surface,

wherein each vertex includes a prism angle having a prism axis that is perpendicular to the longitudinal axis and the opposing second planar surface, the prism axis dividing the prism angle into a first vertex angle proximate the light input end and a different second vertex angle proximate the opposing end; and

wherein the first vertex angle is larger than the second vertex angle.

2. The luminaire of claim 1, further comprising a light source capable of injecting light into the light duct through the light input end, the opposing end, or both the light input end and the opposing end.

3. The luminaire of claim 1, further comprising a light source capable of injecting light into the light duct through the light input end, wherein the opposing end comprises a reflective surface capable of reflecting incident light toward the light input end.

4. The luminaire of claim 1, wherein a light ray that intersects the plurality of voids exits the cavity and is turned by the asymmetric turning film within a first plane parallel to the longitudinal axis to an output angle, the output angle being within an angular spread of a central output direction, wherein the central output direction does not intersect a second plane perpendicular to the longitudinal axis and passing through the opposing end.

5. The luminaire of claim 1, further comprising a steering film adjacent the opposing planar surface of the asymmetric turning film, the steering film having a plurality of parallel ridges parallel to the longitudinal axis configured to refract a light ray exiting the asymmetric turning film into a steered direction within a third plane perpendicular to the longitudinal axis.

6. The luminaire of claim 1, wherein the plurality of voids includes an areal density that varies along the longitudinal axis.

7. The luminaire of claim 1, wherein the output surface is a planar surface or a curved surface.

8. A luminaire, comprising:

a light duct having a longitudinal axis, light input end, an opposing end, and a reflective interior surface surrounding a cavity;

a light output region including a plurality of voids disposed in the reflective interior surface, whereby light can exit the cavity;

an asymmetric turning film, comprising:

a first surface including parallel prismatic microstructures, each having a vertex adjacent the light output region and aligned perpendicular to the longitudinal axis;

an opposing second planar surface; and

a light source disposed to inject a light beam into the light duct through the light input end,

wherein each vertex includes a prism angle having a prism axis that is perpendicular to the longitudinal axis and the opposing second planar surface, the prism axis dividing the prism angle into a first vertex angle proximate the light input end and a different second vertex angle proximate the opposing end; and

wherein the first vertex angle is larger than the second vertex angle.

9. The luminaire of claim 8, wherein the opposing end comprises a reflective surface capable of reflecting light from the light source back toward the light input end, or a second light source capable of injecting a second light beam into the light duct.

10. The luminaire of claim 8, wherein a first light ray having a first propagation direction toward the opposing end that intersects the plurality of voids, exits the cavity, and is turned by the asymmetric turning film within a first angular spread from a plane perpendicular to the longitudinal axis, and wherein a second light ray having a second propagation direction toward the light input end intersects the plurality of voids, exits the cavity, and is turned by the asymmetric turning film within a second angular spread from the plane perpendicular to the longitudinal axis.

11. The luminaire of claim 10, wherein the first angular spread and the second angular spread each comprise a central output direction that does not intersect a second plane perpendicular to the longitudinal axis and passing through the opposing end.

12. The luminaire of claim 8, further comprising a steering film adjacent the opposing planar surface of the asymmetric turning film, the steering film having a plurality of parallel ridges parallel to the longitudinal axis configured to refract a light ray from the asymmetric turning film into a steered direction within a third plane perpendicular to the longitudinal axis.

13. The luminaire of claim 8, wherein the light source comprises at least one collimating horn and a light emitting diode (LED) disposed to inject light into the collimating horn.

14. The luminaire of claim 8, wherein the light beam includes a collimation half-angle no greater than about 10 degrees.

15. The luminaire of claim 10, wherein the first angular spread and the second angular spread are each less than about 10 degrees.

16. The luminaire of claim 8, wherein the first vertex angle is about 37 degrees, and the second vertex angle is about 35 degrees.

17. The luminaire of claim 8, further comprising a battery to power the light source.

18. The luminaire of claim 17, further comprising a solar cell capable of charging the battery.

19. The luminaire of claim 8, wherein the light source is controlled by an attached switch, a wired connection, a wireless connection, a timer, or a combination thereof.

20. The luminaire of claim 8, further comprising a housing that at least partially encloses the light duct, the light output region, the asymmetric turning film, and the light source.