DRIP CHAMBER WITH HYDROPHOBIC INTERIOR SURFACE

TECHNICAL FIELD

[0001] The present disclosure relates to a drip chamber, for an infusion tube, with an interior surface having a hydrophobic surface, in particular, a hydrophobic surface with optical properties enabling optical imaging through the hydrophobic surface.

BACKGROUND

[0002] Figure 5 is a pictorial representation of prior art drip chamber **200** with spurious droplets **202** clinging to interior surface **204** of the drip chamber. For purposes of illustration, Figure 5 is presented as a line drawing. During operation of drip chamber **200**, when fluids are flowing through the drip chamber, droplets of fluid, such as droplets **202**, form on the interior surface of the drip chamber due to splashing of the fluid, or by evaporation of the fluid from the reservoir at the bottom of the drip chamber and subsequent condensation of the fluid on the interior surface. Droplets **202** can cause substantial problems with respect to imaging the drip chamber, for example, imaging drop **206** pendant from drip tube **208**. For example, the droplets can cause errors in the measurement of the size of drop **206**. Droplets such as droplets **202** in other portions of the drip tube, for example in the vicinity of a meniscus, can cause similar problems, such as errors in measuring a position/level of the meniscus.

SUMMARY

[0003] According to aspects illustrated herein, there is provided a drip chamber for an infusion tube, including: a first end including a drip tube; a second end including an exit port; and a wall connecting the first and second ends and including an interior surface with a hydrophobic portion. The drip chamber includes a space enclosed by the interior ~~wall~~ surface and the first and second ends. The hydrophobic portion of the interior surface repels liquid contacting the hydrophobic ~~coating~~portion. The hydrophobic portion of the interior surface enables light to refract through the hydrophobic portion and the wall in the same manner as is the case when the hydrophobic portion is not present on the interior surface.

[0004] According to aspects illustrated herein, there is provided a method of fabricating a drip chamber for an infusion tube, including: forming a first end including a drip tube; forming a second end including an exit port; forming a wall connecting the first and second ends and including an interior surface; forming a hydrophobic portion on the interior surface; and enclosing a space with the interior surface and the first and second ends. The hydrophobic portion of the interior surface repels liquid contacting the hydrophobic ~~coating~~portion. The hydrophobic portion of the interior surface enables light to refract through the hydrophobic portion and the wall in the same manner as is the case when the hydrophobic portion is not present on the interior surface.

[0005] According to aspects illustrated herein, there is provided an optical imaging system for an infusion tube, including: a drip chamber with: a first portion with a drip tube; a second portion with an exit port; a third portion located between the first and second portions; and a wall connecting the first and second ends and including an interior surface with a portion having a hydrophobic portion of the interior surface aligned with at least one of the first or third portions in a direction orthogonal to a longitudinal axis for the drip chamber passing through the first and second ends. The system includes: at least one light source for emitting light; and an optics system including at least one lens for receiving and transmitting the light transmitted through the hydrophobic portion of the interior surface and the at least one of the first or third portions, and an image sensor for receiving the transmitted light from the at least one lens and generating and transmitting data characterizing the transmitted light from the at least one lens. The system includes a memory element configured to store computer readable instructions and at least one specially programmed processor configured to execute the computer readable instructions to generate, using the data, at least one image of the at least one of the first or third portions. The hydrophobic portion of the interior surface repels liquid contacting the hydrophobic portion of the interior surface. The hydrophobic portion of the interior surface enables the light to pass through the hydrophobic portion of the interior surface without scattering.

[0006] According to aspects illustrated herein, there is provided a method of imaging an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, a third portion located between the first and second portions, and a wall connecting the first and second ends and including an interior surface with a portion having a hydrophobic portion of the interior surface aligned with at least

CLAIMS

1. A drip chamber for an infusion tube, comprising:

a first end ~~(106)~~ including a drip tube ~~(108)~~;

a second end ~~(110)~~ including an exit port ~~(112)~~;

a wall ~~(114)~~:

connecting the first and second ends; and,

including an interior surface ~~(116)~~ with a hydrophobic portion ~~(118)~~; and,

a space ~~(122)~~ enclosed by the interior ~~wall~~surface and the first and second ends, wherein:

the hydrophobic portion of the interior surface repels liquid contacting the hydrophobic ~~coating~~portion; and,

the hydrophobic portion of the interior surface enables light to refract through the hydrophobic portion and the wall in the same manner as is the case when the hydrophobic portion is not present on the interior surface.

2. The drip chamber of claim 1, wherein the hydrophobic portion of the interior surface enables direct mapping of the light passing through the hydrophobic portion of the interior surface from a point within the drip chamber to a point on an image of the point in the drip chamber.

3. The drip chamber of claim 1, wherein the hydrophobic portion of the interior surface is aligned with the end of the drip tube in a direction orthogonal to a longitudinal axis for the drip chamber passing through the first and second ends of the drip chamber.

4. The drip chamber of claim 1, wherein when the drip chamber includes fluid ~~(124)~~ disposed in the drip chamber, the hydrophobic portion ~~(118)~~ of the interior surface is aligned with a meniscus ~~(140)~~ for the fluid in a direction orthogonal to a longitudinal axis for the drip chamber passing through the first and second ends of the drip chamber.

5. The drip chamber of claim 1, wherein:

a contact angle for a liquid in contact with the hydrophobic portion of the interior surface is between 90 and 180 degrees; and,

the contact angle is an angle, measured through the liquid, where a liquid interface contacts the hydrophobic portion of the interior surface.

6. The drip chamber of claim 1, wherein the hydrophobic portion of the interior surface includes a first plurality of periodic structures.

7. The drip chamber of claim 1, wherein the hydrophobic portion of the interior surface includes a first plurality of structures in a non-periodic configuration.

8. The drip chamber of claim 1, wherein the hydrophobic portion ~~of the interior surface~~ is formed of a same piece of material forming the interior surface of the wall ~~(114)~~.

9. The drip chamber of claim 1, wherein:

the hydrophobic portion ~~of the interior surface~~ is formed of a first material, separate from a second material forming the interior surface of the wall; and,

the first material is adhered to the second material.

10. The drip chamber of claim 1, wherein the hydrophobic portion of the interior surface reflects less than one tenth of one percent of light incident upon the hydrophobic portion of the interior surface.

11. The drip chamber of claim 1, wherein the hydrophobic portion of the interior surface repels:

a first inorganic liquid including water;

a first organic liquid including alcohols, proteins, or oils;

a solution of a second inorganic liquid with a dissolved first inorganic substance;

a solution of a third inorganic liquid with a dissolved first organic substance;

a solution of a second organic liquid with a dissolved second inorganic substance;

or,

a solution of a third organic liquid with a dissolved second organic substance.

12. A method of fabricating a drip chamber for an infusion tube, comprising:

forming a first end including a drip tube;

forming a second end including an exit port;

forming a wall connecting the first and second ends and including an interior surface with a hydrophobic portion; and;

enclosing a space with the interior surface and the first and second ends, wherein:

the hydrophobic portion of the interior surface repels liquid contacting the hydrophobic ~~coating~~portion; and,

the hydrophobic portion of the interior surface enables light to refract through the hydrophobic portion and the wall in the same manner as is the case when the hydrophobic portion is not present on the interior surface.

13. The method of claim 12, wherein the hydrophobic portion of the interior surface enables direct mapping of the light passing through the hydrophobic portion of the interior surface from a point within the drip chamber to a point on an image of the point in the drip chamber.

14. The method of claim 12, wherein the hydrophobic portion of the interior surface is aligned with the end of the drip tube in a direction orthogonal to a longitudinal axis for the drip chamber passing through the first and second ends of the drip chamber.

15. An optical imaging system for an infusion tube, comprising:

a drip chamber ~~(102)~~ including:

a first portion with a drip tube ~~(108)~~;

a second portion with an exit port ~~(112)~~;

a third portion located between the first and second portions; and,

a wall ~~(114)~~:

connecting the first and second ends; and,

including an interior surface ~~(116)~~ with a hydrophobic portion~~(118)~~ aligned with at least one of the first or third portions in a direction orthogonal to a longitudinal axis for the drip chamber passing through the first and second ends;

at least one light source ~~(126)~~ for emitting light;

an optics system including:

at least one lens ~~(148)~~ for receiving and transmitting the light transmitted through the hydrophobic portion of the interior surface and the at least one of the first or third portions; and,

an image sensor ~~(150)~~ for:

receiving the transmitted light from the at least one lens; and,

generating and transmitting data characterizing the transmitted light from the at least one lens;

a memory element ~~(160)~~ configured to store computer readable instructions; and,

at least one specially programmed processor ~~(156)~~ configured to execute the computer readable instructions to generate, using the data, at least one image of the at least one of the first or third portions, wherein:

the hydrophobic portion of the interior surface repels liquid contacting the hydrophobic portion of the interior surface; and,

the hydrophobic portion of the interior surface enables the light to pass through the hydrophobic portion of the interior surface without scattering.

16. The optical imaging system of claim 15, wherein the hydrophobic portion of the interior surface enables direct mapping of the light from respective points within the first or third portions to respective points on the at least one image.

17. A method of imaging an infusion tube having a drip chamber including a first portion with a drip tube, a second portion with an exit port, a third portion located between the first and second portions, and a wall connecting the first and second ends and including an interior surface with a hydrophobic portion aligned with at least one of the first or third portions in a direction orthogonal to a longitudinal axis for the drip chamber passing through the first and second ends, comprising:

repelling liquid contacting the hydrophobic portion of the interior surface;

emitting, using at least at least one light source, light;

transmitting the light through the hydrophobic portion of the interior surface and at least one of the first or third portions without scattering the light;

receiving, using at least one lens, the light transmitted through the hydrophobic portion of the interior surface and the at least one of first and third portions;

transmitting, through the at least one lens, the light transmitted through the hydrophobic portion of the interior surface and the at least one of the first or third portions;

receiving, using an image sensor, the transmitted light from the at least one lens;

generating and transmitting, using the image sensor, data characterizing the transmitted light from the at least one lens;

storing computer readable instructions in a memory element; and,

executing the computer readable instructions, using at least one specially programmed processor and the data, to generate at least one image of the at least one of the first or third portions.

18. The method of claim 17, further comprising:

directly mapping, using the at least one specially programmed processor, the light from respective points within the at least one of the first or third portions to respective points on the at least one image.