Claims

1. A membrane having a first surface and a second surface, the first and second surfaces oppose each other, the membrane comprising:

(a) an opening penetrating through the membrane and is sized to retain a microsphere,

wherein the opening is tapered, the size of the opening on the first surface is larger than the size of the opening on the second surface; and

wherein the surface of the surface of the membrane is coated with a metal.

2. The membrane according to claim 1, wherein an angle formed between a central axis of the opening and the side of the opening is larger than a maximal half-angle θ of a cone of light that can exit an objective lens of a microscope, the maximal half-angle θ which is derived from the numerical aperture of the objective lens of a microscope, when the microsphere is placed between the objective lens and a surface of a sample for imaging the sample.

3. The membrane according to claim 2, wherein the angle is larger than 64 degrees.

4. The membrane according to any one of the preceding claims, wherein the inner profile of the opening is frusto-conical.

5. The membrane according to claim 1, wherein the metal is any one selected from the group comprising: gold, silver, chromium, aluminium, copper, or combinations thereof.

6. The membrane according to any one of the preceding claims, wherein the opening is sized to retain a microsphere having a diameter between 4 μm to 50 μm, the size of the opening of the first surface is larger than the diameter of the microsphere, and the size of the opening on the second surface is smaller than the diameter of the microsphere.

7. The membrane according to claim 6, wherein the thickness of the membrane is equal to or less than the diameter of the microsphere.

8. The membrane according to any one of the preceding claims, wherein the membrane is made from a material selected from the group comprising: silicon, silica, sapphire, a polystyrene, a poly(methyl methacrylate), a polycarbonate, a poly(ethylene terephthalate), or combinations thereof.

9. A device comprising the membrane according to any one of claims 1 to 8, wherein the membrane is coupled to a support structure configured in such a way that is suitable for positioning the microsphere between the objective lens of a microscope and a surface of a sample for imaging the sample.

10. The device according to claim 9, wherein the support structure is configured in such a way that is suitable for positioning the microsphere at a pre-determined distance above the surface of the sample.

11. The device according to any one of claims 9 or 10, wherein the pre-determined distance is less than 1 μm.

12. The device according to any one of claims 9 to 11, wherein the support structure is a nano-stage comprising a cantilever, the membrane retaining the microsphere is coupled to the distal end of the cantilever.

13. The device according to any one of claims 9 to 11, wherein the support structure is a frame comprising at least one arm extending from a side of the frame into the interior space of the frame, the membrane retaining the microsphere is coupled to the at least one arm.

14. The device according to claim 13, wherein the frame comprising a least one arm extending from opposing sides of the frame into the interior space of the frame, the membrane retaining the microsphere is disposed between the opposing arms.

15. The device according to claim 14, wherein the arms are attached to the frame by screw threads, the screw action of these threads adjusts the position of the membrane above the surface of the sample.

16. The device according to any one of claims 9 to 15, wherein the support structure is configured to position the microsphere anywhere along an *x*-, *y*- or *z*-axis direction.

17. A system for imaging a sample, the system comprising:

(a) an optical component; and

(b) the device according to any one of claims 9 to 16.

18. A method for imaging a sample, the method comprising:

(a) retaining a microsphere in a membrane according to any one of claims 1 to 8;

(b) positioning the microsphere above the surface of the sample;

(c) illuminating the surface of the sample, whereby light reflected from the surface is reflected through the microsphere and focused through an optical component; and

(d) detecting the light to form an image of the surface.

19. The method according to claim 18, wherein the microsphere is positioned at a predetermined distance of less than 1 µm above the surface of the sample.