CLAIMS

1. A metrology tool, comprising:

an objective to deliver radiation to a surface and to receive radiation redirected by the surface;

a detector to receive the redirected radiation from the objective; and

an illumination system to deliver the radiation for redirection to the objective, the illumination system comprising a catadioptric optical system,

wherein the catadioptric optical system is configured to output a collimated beam.

2. The metrology tool of claim 1, wherein the objective comprises an objective catadioptric optical system.

3. The metrology tool of claim 1, wherein the metrology tool is a scatterometer.

4. The metrology tool of claim 1, wherein the catadioptric optical system, comprises:

a first reflective surface positioned and configured to reflect radiation;

a second reflective surface positioned and configured to reflect radiation reflected from the first reflective surface as the collimated beam, the second reflective surface having an aperture to allow transmission of radiation through the second reflective surface; and

a channel structure extending from the aperture toward the first reflective surface and having an outlet, between the first reflective surface and the second reflective surface, to supply radiation to the first reflective surface.

5. The metrology tool of claim 4, wherein the catadioptric optical system comprises a first solid transmissive element part, the second reflective surface forms or is on a surface of the first solid transmissive element part and the channel structure comprises a channel aperture through the first solid transmissive element part.

6. The metrology tool of claim 1, configured to transmit all wavelengths of radiation from the range of approximately 193 to 1050 nanometers.

7. The metrology tool of claim 1, configured to obscure approximately 15% or less of the radiation by pupil radius.

8. A catadioptric optical system, comprising:

a first reflective surface positioned and configured to reflect radiation;

a second reflective surface positioned and configured to reflect radiation reflected from the first reflective surface as a collimated beam, the second reflective surface having an aperture to allow transmission of radiation through the second reflective surface; and

a channel structure extending from the aperture toward the first reflective surface and having an outlet, between the first reflective surface and the second reflective surface, to supply radiation to the first reflective surface,

wherein the catadioptric optical system outputs the collimated beam.

9. The catadioptric optical system of claim 8, comprising a first solid transmissive element part, wherein the second reflective surface forms or is on a surface of the first solid transmissive element part.

10. The catadioptric optical system of claim 9, comprising a second solid transmissive element part adjacent the first solid transmissive element part, wherein the first reflective surface forms or is on a surface of the second solid transmissive element part.

11. The catadioptric optical system of claim 9, wherein the channel structure comprises a channel aperture through the first solid transmissive element part.

12. The catadioptic optical system of claim 9, wherein the outlet is at an interface between the first solid transmissive element part and the second solid transmissive element part.

13. The catadioptic optical system of claim 9, wherein the first and second solid transmissive element parts are portions of a monolithic solid transmissive element.

14. The catadioptric optical system of claim 8, wherein a fluid surrounds the channel structure, extends between the first and second reflective surfaces, and is located at least within an outer lateral boundary of the first reflective surface or the second reflective surface.

15. The catadioptric optical system of claim 8, further comprising an optical fiber extending in or forming the channel structure.

16. The catadioptric optical system of claim 8, wherein the first reflective surface comprises a convex reflective surface.

17. The catadioptric optical system of claim 8, wherein the beam from the second reflective surface passes through a surface substantially perpendicular to the beam direction.

18. A metrology method, comprising:

delivering radiation to a surface using an objective;

receiving radiation redirected by the surface using the objective;

detecting a parameter of the surface using the redirected radiation from the objective;

and delivering the radiation for redirection to the objective using a catadioptric optical system, wherein the catadioptric optical system outputs a collimated beam.

19. The metrology method of claim 18, wherein the objective comprises a catadioptric optical system.

20. The metrology method of claim 18, wherein the objective is part of a scatterometer.

21. The metrology method of claim 18, wherein delivering the radiation comprises:

reflecting radiation using a first reflective surface of the catadioptic optical system; and

reflecting radiation reflected from the first reflective surface using a second reflective surface to form the collimated beam, the second reflective surface having an aperture to allow transmission of radiation through the second reflective surface,

CLAIMS

1. A metrology tool with a catadioptric optical system as part of an illumination system; the catadioptric system being configured to ouput a collimated beam and comprising:

a first reflective surface positioned and configured to reflect radiation,

a second reflective surface positioned and configured to reflect radiation reflected from the first reflective surface as a the collimated beam, the second reflective surface having an aperture to allow transmission of radiation through the second reflective surface;

a first solid transmissive element part, wherein the second reflective surface forms or is on a surface of the first solid transmissive element part;

a second solid transmissive element part adjacent the first solid transmissive element part, wherein the first reflective surface forms or is on a surface of the second solid transmissive element part; and

a channel structure extending from the aperture toward the first reflective surface and having an outlet, between the first reflective surface and the second reflective surface, to supply radiation to the first reflective surface and further comprising a channel aperture through the first solid transmissive element part;

2. The metrology tool of claim 1, further comprising an objective to deliver radiation to a surface and to receive radiation redirected by the surface;

3. The metrology tool of claim 2, further comprising a detector to receive the redirected radiation from the objective;

4. The metrology tool of claim 2, wherein the objective comprises an objective catadioptric optical system.

5. The metrology tool of the preceding claims, wherein the metrology tool is a scatterometer.

6. The metrology tool of claim 1, configured to transmit all wavelengths of radiation from the range of approximately 193 to 1050 nanometers.

7. The metrology tool of claim 1, configured to obscure approximately 15% or less of the radiation by pupil radius.

8. The catadioptric optical system of claim 1, wherein the channel structure comprises a channel aperture through the first solid transmissive element part.

9. The catadioptic optical system of claim 1, wherein the outlet is at an interface between the first solid transmissive element part and the second solid transmissive element part.

10. The catadioptic optical system of claim 1, wherein the first and second solid transmissive element parts are portions of a monolithic solid transmissive element.

11. The catadioptric optical system of claim 1, wherein a fluid surrounds the channel structure, extends between the first and second reflective surfaces, and is located at least within an outer lateral boundary of the first reflective surface or the second reflective surface.

12. The catadioptric optical system of claim 1, further comprising an optical fiber extending in or forming the channel structure.

13. The catadioptric optical system of claim 1, wherein the first reflective surface comprises a convex reflective surface.

14. The catadioptric optical system of claim 1, wherein the beam from the second reflective surface passes through a surface substantially perpendicular to the beam direction.

15. A metrology method, comprising:
delivering radiation to a surface using an objective;
receiving radiation redirected by the surface using the objective;

detecting a parameter of the surface using the redirected radiation from the objective; and

delivering the radiation for redirection to the objective using a catadioptric optical system comprising of a reflective surface forming or being on the surface of a solid transmissive element, wherein the catadioptric optical system outputs a collimated beam.

16. The metrology method of claim 15, wherein the objective comprises a catadioptric optical system.

17. The metrology method of claim 15, wherein the objective is part of a scatterometer.

18. The metrology method of claim 15, wherein delivering the radiation comprises:

reflecting radiation using a first reflective surface of the catadioptic optical system; and

reflecting radiation reflected from the first reflective surface using a second reflective surface to form the collimated beam, the second reflective surface having an aperture to allow transmission of radiation through the second reflective surface,

wherein a channel structure extends from the aperture toward the first reflective surface and has an outlet, between the first reflective surface and the second reflective surface, to supply radiation to the first reflective surface.