Claims

~~What is claimed is:~~

1. A structured illumination imaging system, comprising:

a first optical arm, comprising:

a first light emitter to emit light; and

a first beam splitter to split light emitted by the first light emitter to project a first plurality of fringes on a plane of a sample;

a second optical arm, comprising:

a second light emitter to emit light; and

a second beam splitter to split light emitted by the second light emitter to project a second plurality of fringes on the plane of the sample;

wherein the first beam splitter comprises a first transmissive diffraction grating and the second beam splitter comprises a second transmissive diffraction grating; and

an optical element to combine an optical path of the first arm and the second arm;

wherein the optical element to combine an optical path of the first plurality of fringes and the second plurality of fringes comprises a mirror with holes, with the mirror arranged to reflect light diffracted by the first transmissive diffraction grating and with the holes arranged to pass through at least first orders of light diffracted by the second transmissive diffraction grating.

~~2. The structured illumination imaging system of claim 1, wherein the first beam splitter comprises a first transmissive diffraction grating and the second beam splitter comprises a second transmissive diffraction grating.~~

~~3.~~2. The structured illumination imaging system of claim ~~2~~1, wherein the first and second light emitters emit unpolari~~z~~sed light, and wherein the first and second transmissive diffraction gratings are to diffract unpolari~~z~~sed light emitted by a respective one of the first and second light emitters.

~~4. The structured illumination imaging system of claim 2, wherein the optical element to combine an optical path of the first plurality of fringes and the second plurality of fringes comprises a mirror with holes, with the mirror arranged to reflect light diffracted by the first diffraction grating and with the holes arranged to pass through at least first orders of light diffracted by the second diffraction grating.~~

~~5.~~3. The structured illumination imaging system of ~~claim 4~~ any one of the preceding claims, further comprising: one or more optical elements to phase shift the first plurality of fringes and the second plurality of fringes.

~~6.~~4. The structured illumination imaging system of claim ~~5~~3, wherein the one or more optical elements to phase shift the first plurality of fringes and the second plurality of fringes comprise a first rotating optical window to phase shift the first plurality of fringes and a second rotating optical window to phase shift the second plurality of optical fringes.

~~7.~~5. The structured illumination imaging system of either claim ~~5~~3 or claim 4, wherein the one or more optical elements to phase shift the first plurality of fringes and the second plurality of fringes comprise a first linear motion stage to translate the first transmissive diffraction grating and a second linear motion stage to translate the second transmissive diffraction grating.

~~8.~~6. The structured illumination imaging system of any one of claims 3 to 5, wherein the one or more optical elements to phase shift the first plurality of fringes and the second plurality of fringes comprise a single rotating optical window, wherein the single rotating optical window is positioned after the mirror with holes in an optical path to the sample.

~~9.~~7. The structured illumination system of claim ~~8~~6, wherein an axis of rotation of the single rotating optical window is offset by about 45 degrees from an optical axis of each of the gratings.

~~10.~~8. The structured illumination imaging system of any one of claims ~~5~~3 to 7, wherein the first plurality of fringes are angularly offset from the second plurality of fringes on the sample plane by about 90 degrees.

~~11.~~9. The structured illumination system of claim ~~10~~8, wherein the sample comprises a plurality of features regularly patterned in a rectangular array or hexagonal array.

~~12.~~10. The structured illumination system of any one of claims ~~5~~3 to 9, further comprising: an objective lens to project each of the first plurality of fringes and the second plurality of fringes on the sample.

~~13.~~11. The structured illumination system of any one of claims ~~5~~3 to 10, further comprising: one or more optical beam blockers for blocking zero orders of light emitted by each of the first and second transmissive diffraction gratings.

~~14.~~12. The structured illumination system of claim ~~13~~11, wherein the one or more optical beam blockers comprise a Bragg grating.

~~15.~~13. The structured illumination system of ~~claim 2~~ any one of the preceding claims, wherein the optical element to combine an optical path of the first arm and the second arm comprises a polari~~z~~sing beam splitter, wherein the first transmissive diffraction grating diffracts vertically polari~~z~~sed light and wherein the second transmissive diffraction grating diffracts horizontally polari~~z~~sed light.

~~16.~~14. The structured illumination imaging system of ~~claim 1~~ any one of the preceding claims, wherein the first and second beam splitters each comprise a beam splitter cube or plate.

~~17.~~15. The structured illumination imaging system of ~~claim 1~~ any one of the preceding claims, wherein the first beam splitter comprises a first reflective diffraction grating and the second beam splitter comprises a second reflective diffraction grating.

~~18.~~16. A method, comprising:

turning on a first optical arm of a structured illumination system, the first optical arm comprising a first light emitter to emit light and a first transmissive diffraction grating to diffract light emitted by the first light emitter to project a first plurality of fringes oriented in a specific direction on a plane of a sample;

capturing a first plurality of phase images of the sample, wherein during capture of the first plurality of images, the positions of the first plurality of fringes are shifted on the plane of the sample;

turning on a second optical arm of the structured illumination system, the second optical arm comprising a second light emitter to emit light and a second ~~diffraction~~ transmissive grating to diffract light emitted by the second light emitter to project a second plurality of fringes on the

plane of the sample, wherein the second plurality of fringes are angularly offset from the first plurality of fringes on the plane of the sample; and

capturing a second plurality of phase images of the sample illuminated with the second plurality of fringes, wherein during capture of the second plurality of fringes, the positions of the second plurality of fringes are shifted on the plane of the sample~~.~~;

~~19. The method of claim 18, wherein the first diffraction grating and the second diffraction grating are transmissive diffraction gratings,~~ wherein the structured illumination system comprises a mirror with holes to reflect light diffracted by the first transmissive diffraction grating and to pass through at least first orders of light diffracted by the second transmissive diffraction grating.

~~20.~~17. The method of claim ~~19~~16, further comprising: using at least the first plurality of captured phase images and the second plurality of captured phased images to computationally reconstruct one or more images having higher resolution than each of the first and second pluralities of captured phased images.

~~21.~~18. The method of claim ~~20~~17, wherein the first plurality of fringes are angularly offset from the second plurality of fringes on the sample plane by about 90 degrees.

~~22.~~19. The method of claim ~~21~~18, wherein the sample comprises a plurality of features regularly patterned in a rectangular array or hexagonal array.

~~23.~~20. The method of any one of claims ~~18~~16 to 19, wherein the first plurality of fringes and the second plurality of fringes are phase shifted by rotating a single optical window positioned in an

optical path between the sample and each of the first and second gratings, wherein an axis of rotation of the single rotating optical window is offset from an optical axis of each of the gratings.

~~24.~~21. The method of any one of claims ~~18~~16 to 20, wherein the first optical arm is turned off and the second optical arm of the structured illumination system is turned on after capturing the first plurality of phase images.

~~25.~~22. The method of any one of claims ~~19~~16 to 21, wherein the first transmissive diffraction grating and the second transmissive diffraction grating are mechanically fixed during image capture.