

CLAIMS

1. An integrated device comprising:
 - a substrate having a first surface; and
 - a plurality of pixels formed on the substrate, at least some of the plurality of pixels comprising:
 - a reaction chamber configured to receive a sample;
 - a sensor configured to detect emission radiation emitted from the reaction chamber;
 - a waveguide configured to couple excitation radiation to the reaction chamber;
 - and
 - an optical nanostructure disposed between the waveguide and the sensor, wherein the optical nanostructure is patterned to include structural variations in a plane substantially parallel to the first surface of the substrate and reject at least a portion of the excitation radiation incident on the optical nanostructure in a direction substantially normal to the first surface.
2. The integrated device of claim 1, wherein the structural variations are periodic or quasi-periodic at least in one dimension in the plane.
3. The integrated device of claim 1 or claim 2, wherein the optical nanostructure exhibits a photonic bandgap.
4. The integrated device of any one of claims 1-3, wherein the structural variations are periodic or quasi-periodic in two dimensions in the plane.
5. The integrated device of any one of claims 1-4, wherein the structural variations exhibit a periodicity between 150 nm and 500 nm.
6. The integrated device of any one of claims 1-5, wherein the optical nanostructure has no missing or significantly different periodic component within the structural variations.
7. The integrated device of any one of claims 1-6, wherein the optical nanostructure comprises a first plurality of discrete regions of a dielectric material having a first refractive index.

8. The integrated device of claim 7, wherein the first plurality of discrete regions of the dielectric material exhibit a width, in the plane, between 100 nm and 300 nm.
9. The integrated device of claim 7 or claim 8, wherein the optical nanostructure comprises a second plurality of discrete regions of the dielectric material, the first and second discrete regions of the dielectric material being spaced from each other along a direction perpendicular to the first surface of the substrate.
10. The integrated device of claim 9, wherein the first and second discrete regions of dielectric material are staggered from each other along the direction parallel to the plane.
11. The integrated device of any one of claims 7-10, wherein the first plurality of discrete regions of the dielectric material are separated by regions of a material having a second refractive index different than the first refractive index.
12. The integrated device of any one of claims 7-11, wherein the first plurality of discrete regions of the dielectric material extend in a direction perpendicular to the plane.
13. The integrated device of claim 12, wherein the first plurality of discrete regions of the dielectric material exhibit a height, along the direction perpendicular to the first surface of the substrate, between 100 nm and 300 nm.
14. The integrated device of any one of claims 1-13, further comprising an iris disposed between the reaction chamber and the sensor.
15. The integrated device of any one of claims 1-14, further comprising an optical element disposed between the reaction chamber and the sensor that increases a concentration of the emission radiation onto the sensor.
16. The integrated device of claim 15, wherein the optical element comprises a disk of dielectric material having, for a same wavelength of the emission radiation, a first index of refraction that is different from a second index of refraction for material surrounding the disk.
17. A method of operating an integrated device, the method comprising:
coupling, from a waveguide formed on a substrate, excitation radiation to a reaction chamber formed adjacent to the waveguide, the excitation radiation having a first wavelength;

passing emission radiation from the reaction chamber through an optical nanostructure to a sensor, wherein the optical nanostructure is patterned to include structural variations in a plane substantially parallel to a first surface of the substrate, and wherein the emission radiation has a second wavelength different than the first wavelength and is generated in response to excitation of at least one emitter in the reaction chamber by the excitation radiation; and

rejecting at least a portion of the excitation radiation with the optical nanostructure.

18. The method of claim 17, further comprising detecting at least a portion of the emission radiation which passes through the optical nanostructure with a sensor formed on the substrate.

19. The method of claim 17 or claim 18, wherein rejecting a portion of the excitation radiation comprises causing the portion of the excitation radiation to reflect from the optical nanostructure.

20. The method of any one of claims 17-19, wherein the first wavelength is within a photonic bandgap of the optical nanostructure.

21. The method of claim 20, wherein the second wavelength is outside the photonic bandgap of the optical nanostructure.

22. The method of any one of claims 17-21, wherein the structural variations are periodic or quasi-periodic at least in one dimension in the plane.

23. The method of any one of claims 17-22, wherein the structural variations are periodic or quasi-periodic in two dimensions in the plane.

24. The method of any one of claims 17-23, further comprising passing the emission radiation from the reaction chamber through an iris.

25. The method of claim 24, further comprising rejecting the excitation radiation with the iris.

26. The method of any one of claims 17-25, further comprising concentrating the emission radiation with a dielectric disk located between the reaction chamber and optical nanostructure.

27. A method for fabricating an integrated device, the method comprising:

forming, on a substrate having a first surface, a plurality of pixels such that at least some of the plurality of pixels comprises a reaction chamber and a sensor;

forming a waveguide in the at least some of the plurality of pixels; and

forming an optical nanostructure in the at least some of the plurality of pixels between the waveguide and the sensor, wherein forming the optical nanostructure comprises:

patterning a first dielectric material to include structural variations in a plane substantially parallel to the first surface of the substrate.

28. The method of claim 27, wherein patterning a first dielectric material comprises forming periodic or quasi-periodic patterns in the first dielectric material.

29. The method of claim 27 or claim 28, wherein patterning the first dielectric material to include structural variations comprises etching the first dielectric material to form voids in the first dielectric material.

30. The method of claim 29, further comprising filling the voids with a second dielectric material different than the first dielectric material.