CLAIMS

1. An apparatus comprising an illumination system for illuminating an object, said illumination system comprising:

an illumination source,

a coupler,

a light bar, and

a plurality of ~~a~~ patterned metasurfaces, each of which defines a diffraction site which is spaced apart from adjacent diffraction sites,

wherein said coupler couples light from said illumination source into said light bar, ~~-~~ and

wherein, after having undergone total internal reflection within said light bar, ~~and after having interacted with said patterned metasurface,~~ said light exits said light bar through each of the diffraction sites and ~~propagates~~ travels toward said object.

2. The apparatus of claim 1, wherein said plurality of patterned metasurfaces is patterned on a surface of said light bar.

3. The apparatus of claim 1, wherein said plurality of patterned metasurfaces is patterned on a top surface of said light bar, said top surface being a surface that is closest to said object.

4. The apparatus of claim 1, wherein said plurality of patterned metasurfaces is patterned on a bottom surface of said light bar, said bottom surface being a surface that is furthest from said object.

5. The apparatus of claim 1, wherein said light has a wavelength, wherein said plurality of patterned metasurfaces comprises nanostructures of uniform height, wherein said nanostructures are embedded in a medium, and wherein, said nanostructures have a higher refractive index than said medium at said wavelength.

6. The apparatus of claim 3, wherein said light has a wavelength, wherein said plurality of patterned metasurfaces comprises nanostructures of uniform height, wherein said nanostructures are embedded in a medium, and wherein, at said nanostructures have a refractive index greater than two at said wavelength.

7. The apparatus of claim 6, wherein said medium is air.

8. The apparatus of claim 6, wherein said light has a wavelength and wherein said medium is a medium having an index of refraction that is less than two at said wavelength.

9. The apparatus of claim 1, wherein said light bar is configured to cause light from said illumination source to be replicated at each of the diffraction sites~~multiple diffraction locations along said patterned metasurface~~.

10. The apparatus of claim 1, wherein said light bar is configured to cause light from said illumination source to form replicas at each of the diffraction sites~~multiple diffraction locations along said patterned metasurface~~, ~~said replicas~~diffraction sites being separated by distances greater than a coherence length of said illumination source which produces replicas separated by distances greater than the coherence length of said illumination source.

11. The apparatus of claim 1, wherein light from said illumination source forms incoherent replicas at each of the diffraction sites ~~multiple diffraction locations along said patterned metasurface~~.

12. The apparatus of claim 1, wherein the diffraction sites are positioned on the top surface of the light bar such that light from said illumination source forms replicas that are on a top surface of said light bar, as a result of which light is diffracted upon incidence and redirected into free space.

13. The apparatus of claim 1, wherein light from said illumination source forms replicas that are on a bottom surface of said light bar, wherein light incident on said bottom surface becomes diffracted as a result of interaction with said plurality of patterned metasurfaces, wherein, as a result of such interaction said light is no longer totally internally reflected within said light bar and is thus redirected into free space.

14. The apparatus of claim 1, wherein when light directly illuminates said object, a first angular diversity of illumination results, wherein when said light illuminates said object through said light bar, a second angular diversity of illumination results, and wherein said second angular diversity of illumination exceeds said first angular diversity of illumination.

15. The apparatus of claim 1, wherein when light illuminates said object directly, a first speckle results, wherein when said light illuminates said object through said light bar, a second speckle results, and wherein said first speckle has a first contrast, wherein said second speckle has a second contrast, and wherein said first contrast exceeds said second contrast.

16. The apparatus of claim 1, wherein said plurality of patterned metasurfaces is partially reflective and wherein said plurality of patterned metasurfaces is partially transmissive.

17. The apparatus of claim 1, wherein said plurality of patterned metasurfaces has a non-zero reflection coefficient and a non-unity diffraction into a desired order.

18. The apparatus of claim 1, further comprising an air gap, wherein said air gap separates said plurality of patterned metasurfaces from said light bar.

19. The apparatus of claim 1, further comprising a linearly decreasing air gap, wherein said air gap separates said plurality of patterned metasurfaces from said light bar by a distance that varies linearly with position along said light bar.

~~20. An apparatus comprising an illumination system for illuminating an object, said illumination system comprising a VCSEL array having a design wavelength for output light, wherein said VCSEL array comprises lasers and a patterned metasurface, wherein said patterned metasurface causes variations in output wavelengths of said each of said lasers from said design wavelength, whereby said lasers output light at different wavelengths.~~

~~21. The apparatus of claim 20, wherein said patterned metasurface causes light that is output by said lasers to be vary from said design wavelength by more than twenty nanometers.~~

~~22. The apparatus of claim 20, wherein said patterned metasurface comprises first and second layers.~~

~~23. The apparatus of claim 22, wherein said first layer is transmissive at said design wavelength, wherein said second layer imparts phase shift, wherein said phase shift differs for each laser.~~

~~24. The apparatus of claim 20, wherein said patterned metasurface comprises nanostructures with uniform height and a first refractive index, wherein said nanostructures are surrounded by a medium with a second refractive index, wherein said first refractive index exceeds said second refractive index.~~

~~25. The apparatus of claim 24, wherein said first refractive index is at least two.~~

~~26. The apparatus of claim 24, wherein said patterned metasurface has a duty cycle as a parameter, wherein range of phase shifts introduced by changing said duty cycle generates a corresponding range of emission wavelengths.~~

~~27. The apparatus of claim 22, wherein said second layer is a reflective layer having a reflectivity in excess of 90% at said design wavelength.~~

~~28. The apparatus of claim 22, wherein said second layer is a dielectric mirror and said first layer is a metasurface that imparts a different phase shifts for different lasers.~~

~~29. The apparatus of claim 22, wherein said second layer is reflective over all of said different wavelengths.~~

~~30. The apparatus of claim 22, wherein said first and second layers are separated by a material, wherein said material is of uniform thickness, wherein said material has a low refractive index.~~

~~31. An apparatus comprising an illumination system for illuminating an object, said illumination system comprising a VCSEL array and a replicating layer, wherein said array comprises a plurality of sources, each source being a VCSEL, wherein said sources emit light at different wavelengths, wherein said replicating layer is disposed above said array, wherein said replicating layer forms a plurality of synthetic sources for each source, said synthetic sources being incoherent relative to each other.~~

~~32. The apparatus of claim 31, wherein said replicating layer comprises a diffraction grating.~~

~~33. The apparatus of claim 31, wherein said replicating layer comprises a patterned metalayer.~~

~~34. The apparatus of claim 33, wherein said metalayer is configured to both diffract light to form said synthetic sources and to shape beams from said synthetic sources.~~

~~35. An apparatus comprising a diffuser, said diffuser comprising a plurality of patches, each of which comprises a metasurface, wherein each metasurface comprises nanostructures embedded in a medium, where said nanostructures have a refractive index that is greater than that of said medium, and wherein each metasurface carries out a different optical function.~~

~~36. The apparatus of claim 35, wherein said patches are in an ordered arrangement.~~

~~37. The apparatus of claim 35, wherein said patches comprise a first patch and a second patch, wherein said first patch is configured to carry out a first optical function, wherein said second patch is configured to carry out a second optical function, wherein said first and second optical functions are selected from the group consisting of beam steering, beam shaping, collimating, and functioning as a lens.~~

~~38. The apparatus of claim 35, wherein illuminating light is incident on a set of patches, wherein said set of patches carries out a function on said illuminating light, wherein said function is an average of functions carried out by individual patches in said set.~~

~~39. The apparatus of claim 35, wherein each of said patches has a rectangular boundary.~~

~~40. The apparatus of claim 35, wherein each of said patches has a boundary that is based on a Voronoi cell.~~

~~41. The apparatus of claim 35, wherein said patches are arranged at random.~~

~~42. The apparatus of claim 35, wherein said patches define an ordered tiling.~~