CLAIMS

1. An optical pattern projection device, comprising:

one or more light emitters; and

a first optical metasurface coupled to the one or more light emitters, configured to project, reshape and/or split light beams generated by the one or more light emitters to generate a projected light pattern, the first metasurface layer containing at least two superposed phase profiles, performing different functions from each other, each of the at least two phase profiles being configured to modulate, collimate, focus, diverge, deflect, shape, split, diffract, or diffuse the light beams from the one or more light emitters.

2. The device of claim 1, further comprising a second optical metasurface spaced apart from the first optical metasurface, the second optical metasurface containing a light shaping and/or projection phase profile configured to modulate, collimate, focus, diverge, diffuse, and/or deflect the light beams from the one or more light emitters, wherein the first and second optical metasurfaces cooperate with each other to produces a defined relationship between light emitter position or light property and corresponding beam projection angle or light property.

3. The device of claim 2, wherein the defined relationship is a linear relationship between light emitter position and beam projection angle.

4. The device of claim 2, wherein the first and second optical metasurfaces have identical sizes.

5. The device of claim 1, wherein at least one of the at least two superposed phase profiles is configured to split or diffract light so as to spatially or angularly distribute the light beam from each of the one or more light emitters into multiple channels.

6. The device of claim 5, comprising a plurality of light emitters, wherein the projected light pattern including a plurality of sub-patterns each corresponding to one of the light emitters.

7. The device of claim 6, wherein in the projected light pattern, the plurality of sub-patterns are identical in shape and are shifted in positions relative to each other, and wherein the plurality of sub-patterns either overlap each other or are non-overlapping with each other.

8. The device of claim 1, wherein the projected light pattern is a 2-D or 3-D pattern including one or more of arrays of dots, lines, matrices, letters, graphics, holograms, random patterns, gray-scale patterns, uniform patterns, and diffusive patterns.

9. The device of claim 1, wherein the projected light pattern reaches a diagonal field of view of approximately 170°.

10. The device of claim 1, further comprising a spacer positioned between the first optical metasurface and the one or more light emitters.

11. The device of claim 1, wherein the first optical metasurface is flat, curved, or conformally integrated with its substrate.

12. The device of claim 1, wherein the one or more light emitters are one or more light sources, one or more optical channels, an image, or a light pattern.

13. The device of claim 1, comprising a plurality of light emitters, wherein the first optical metasurface is configured to provide different responses for different properties of light from the plurality of light emitters, wherein the properties of light are a wavelength, a polarization, an angle-of-incidence, or an intensity of the light beam.

14. The device of claim 1, wherein the light emitter or plurality of light emitters are configured to emit light beams with same or different properties of light, wherein the properties of light are a wavelength, a polarization, a beam divergence, or an order.

15. An optical pattern projection and detection device comprising the optical pattern projection device of claim 1, further comprising an optical pattern detection device which includes:

another optical metasurface configured to modulate, shape, collimate, focus, diverge, deflect, split, diffract, or diffuse the light beams; and

one or multiple light receivers coupled to the other optical metasurface.

16. The device of claim 15, wherein the first optical metasurface and the other optical metasurface are formed on separate, partially overlapping, or fully overlapping portions of a same substrate.

17. The device of claim 15, wherein the light receiver includes photodetectors or optical channels.

18. An optical pattern projection device, comprising:

a light emitter array including a plurality of light emitters; and

one or more flat optics layers, configured to project and split light beams generated by the plurality of light emitters to generate a projected light pattern, the projected light pattern including a plurality of sub-patterns each corresponding to one of the light emitters, wherein the sub-patterns are identical in shape, are shifted in position relative to each other, and overlap each other.

19. An optical pattern projection and detection device comprising the optical pattern projection device of claim 18, further comprising an optical pattern detection device which includes:

another flat optics layer configured to modulate, shape, collimate, focus, diverge, deflect, split, diffract, or diffuse the light beams; and

a light receiver coupled to the other flat optics layer.

20. An optical pattern projection device, comprising:

a light emitter array including a plurality of light emitters; and

a flat optics layer coupled to the light emitter array, configured to project, reshape and/or split light beams generated by the plurality of light emitters to generate a projected light pattern, the projected light pattern including a plurality of sub-patterns each corresponding to one of the light emitters, wherein the flat optics layer includes superposed phase profiles, including a phase profile for beam collimation and projection in which different regions of the flat optics are configured for coupling light beams from different light emitters, and a beam splitting phase profile configured to spatially distribute the light beam from each light emitter into multiple channels.

21. An optical pattern projection and detection device comprising the optical pattern projection device of claim 20, further comprising an optical pattern detection device which includes:

another flat optics layer configured to modulate, shape, collimate, focus, diverge, deflect, split, diffract, or diffuse the light beams; and

a light receiver coupled to the other flat optics layer.