CLAIMS

1. A method for forming an optical device, comprising:

disposing a first device material layer over a substrate, the first device material layer being a different material from the substrate;

patterning a portion of the first device material layer to form a first plurality of device structures in a top surface of the first device material layer, the first plurality of device structures comprising a first plurality of gratings and a second plurality of gratings;

disposing a second device material layer on the top surface of an unpatterned portion of the first device material layer, the second device material layer being an uncured imprintable material; and

patterning the second device material layer to form a second plurality of device structures in the second device material layer, the second plurality of device structures comprising a third plurality of gratings,

wherein the third plurality of gratings comprises a plurality of blazed device structures or a plurality of staircase device structures, and each of the third plurality of gratings comprises a grating depth extending from the top surface of the first device material layer to a top surface of each of the respective third plurality of gratings.

2. The method of claim 1, wherein the first plurality of gratings correspond to a pupil expansion grating of a waveguide combiner and the second plurality of gratings correspond an output coupling grating of the waveguide combiner.

3. The method of claim 1, wherein the third plurality of gratings correspond to an input coupling grating of a waveguide combiner.

4. The method of claim 1, further comprising disposing a metal coating on the third plurality of gratings.

5. The method of claim 1, wherein patterning the second device material layer comprises patterning with a nano imprint lithography process comprising:

imprinting a master stamp into the second device material layer, the master stamp comprising a plurality of inverse gratings inverse of the third plurality of gratings of the second plurality of device structures;

subjecting the second device material layer to a cure process;

releasing the master stamp from the second device material layer; and

subjecting the second device material layer to an anneal process.

6. The method of claim 1, wherein the first device material layer comprises a high-index film material having a refractive index between about 1.4 and about 3.5.

7. The method of claim 1, wherein the first device material layer comprises silicon oxycarbide (SiOC), titanium dioxide (TiO2), silicon dioxide (SiO2), vanadium (IV) oxide (VOx), aluminum oxide (Al2O3), aluminum-doped zinc oxide (AZO), indium tin oxide (ITO), tin dioxide (SnO2), zinc oxide (ZnO), tantalum pentoxide (Ta2O5), silicon nitride (Si3N4), zirconium dioxide (ZrO2), niobium oxide (Nb2O5), cadmium stannate (Cd2SnO4), or silicon carbon-nitride (SiCN) containing materials.

8. The method of claim 1, wherein the second device material layer comprises a UV curable adhesive, a UV curable resist, or other UV curable polymer.

9. The method of claim 1, wherein the second device material layer comprises a thermally curable thermoplastic or other thermally curable polymer material.

10. The method of claim 1, wherein patterning the portion of the first device material layer comprises performing a lithographic patterning and etch process.

11. A waveguide combiner, comprising:

a substrate;

a first device material layer disposed over the substrate, the first device material layer comprising a material different from the substrate, wherein a first portion of the first device material layer comprises:

an intermediate grating disposed in the first device material layer, and

an output coupling grating disposed in the first device material layer adjacent to the intermediate grating; and

a second device material layer disposed on a portion of a top surface of a second portion of the first device material layer, the second device material layer having an input coupling grating disposed therein, the input coupling grating having a plurality of blazed device structures or a plurality of staircase device structures.

12. The waveguide combiner of claim 11, wherein the input coupling grating comprises a grating depth extending from the top surface of the first device material layer to a top surface of the input coupling grating.

13. The waveguide combiner of claim 11, further comprising a metal coating layer disposed over the input coupling grating.

14. The waveguide combiner of claim 11, wherein the input coupling grating is formed from a nanoimprint lithography process performed on the second device material layer disposed on the top surface of the second portion of the first device material layer.

15. The waveguide combiner of claim 11, wherein the intermediate grating and the output coupling grating are formed by performing a lithographic patterning and etch process in the first portion of the first device material layer.

16. The waveguide combiner of claim 11, wherein the first device material layer comprises a high-index film material having a refractive index between about 1.4 and about 3.5.

17. The waveguide combiner of claim 13, wherein the metal coating layer comprises a reflective metal material.

18. The waveguide combiner of claim 11, wherein the intermediate grating comprises lines (binary), pillars, slanted lines, slanted pillars, saw-tooth, staircase, or blazed device structures.

19. The waveguide combiner of claim 11, wherein the output coupling grating comprises lines (binary), pillars, slanted lines, slanted pillars, saw-tooth, staircase, or blazed device structures.