CLAIMS

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

forming a patterned hardmask over a device material layer, the device material layer disposed on a top surface of a substrate, a first portion of the patterned hardmask exposing a first region of the device material layer, and a second portion of the patterned hardmask exposing a second region of the device material layer;

disposing a first resist layer over the second region of the device material layer such that the first region of the device material layer is exposed;

patterning the first region of the device material layer to form a ~~first~~ plurality of optical features in the first region of the device material layer,

~~deposting~~ disposing a dielectric material between portions of the patterned hardmask and on the device material layer;

disposing a second resist layer over the first region such that the second portion of the patterned hardmask and the dielectric material over the second region are exposed

forming blazed dielectric structures from the dielectric material between portions of the second portion of the patterned hardmask; and

conducting a transfer etch process to form a plurality of blazed optical features in the second region of the device material layer.

2. The method of claim 1, wherein the plurality of optical features comprises a plurality of binary grating structures having top surfaces substantially parallel with the top surface of the substrate, and sidewalls substantially perpendicular to the top surface of the substrate.

3. The method of claim 1, wherein the plurality of blazed optical features comprises a plurality of blazed grating structures.

4. The method of claim 1, wherein patterning the first region of the device material layer to form the plurality of optical features comprises performing a lithographic patterning and etch process in the first region of the device material layer.

5. The method of claim 1, wherein forming blazed dielectric structures from the dielectric material comprises directionally etching the dielectric material on the second region of the device material layer exposed by the second portion of the patterned hardmask.

6. The method of claim 1, wherein forming the patterned hardmask comprises depositing a hardmask material on the device material layer and performing a nanoimprint lithography process to pattern the hardmask material and form the patterned hardmask.

7. The method of claim 1, wherein forming the patterned hardmask comprises: depositing a hardmask material on the device material layer; forming a photoresist stack over the hardmask material, the photoresist stack comprising an organic planarizing layer (OPL), a silicon anti-reflective coating (SiARC), and a photoresist; and patterning the hardmask material using the photoresist stack.

8. The method of claim 1, further comprising removing the patterned hardmask after the plurality of blazed optical features is formed in the second region of the device material layer.

9. The method of claim 1, further comprising removing remaining portions of the dielectric material after the plurality of blazed optical features is formed in the second region of the device material layer.

10. A method of forming an optical device, comprising:

depositing a hardmask material over a device material layer, the device material layer disposed on a top surface of a substrate;

forming a photoresist stack over the hardmask material, the photoresist stack comprising an organic planarizing layer (OPL), a silicon anti-reflective coating (SiARC), and a photoresist;

patterning the hardmask material using the photoresist stack to form a patterned hardmask, a first portion of the patterned hardmask exposing a first region of the device material and a second portion of the patterned hardmask exposing a second region of the device material layer;

disposing a first resist layer over the second region of the device material layer such that the first region of the device material layer is exposed ;

patterning the first region of the device material layer to form a plurality of optical features in the first region of the device material layer;

disposing a dielectric material between portions of the patterned hardmask and on;

disposing a second resist layer over the first region of the device material layer such that second portion of the patterned hardmask and the dielectric material over the second region of the device material layer are exposed;

forming blazed dielectric structures from the dielectric material between portions of the second portion of the patterned hardmask; and

conducting a transfer etch process to form a plurality of blazed optical features in the second region of the device material layer.

11. The method of claim 10, wherein depositing the dielectric material over the first and second regions of the device material layer comprises depositing the dielectric material over the patterned hardmask and etching the dielectric material to expose the patterned hardmask and form a planar surface across a top surface of the dielectric material and a top surface of the patterned hardmask.

12. The method of claim 10, wherein the ~~first~~ plurality of optical features comprises a plurality of binary grating structures in which top surfaces of the plurality of binary grating structures are substantially parallel with the top surface of the substrate and sidewalls of the plurality of binary grating structures are substantially perpendicular to the top surface of the substrate.

13. The method of claim 10, wherein the plurality of blazed optical features comprises a plurality of blazed grating structures.

14. The method of claim 10, further comprising removing the first resist layer after the ~~first~~ plurality of optical features is formed, and removing the second resist layer after the second plurality of optical features is formed.

15. The method of claim 10, further comprising removing the patterned hardmask after removing the remaining portions of the dielectric material over the first region of the device material layer.

16. The method of claim 10, further comprising removing remaining portions of the dielectric material after the plurality of blazed optical features is formed in the second region of the device material layer.

17. An optical device, comprising:

a substrate having a device material layer disposed thereon;

a first grating region formed in a top surface of the device material layer, the first grating region on a first portion of the device material layer and comprising a plurality of binary grating structures having top surfaces substantially parallel with a top surface of the substrate, and sidewalls substantially perpendicular to the top surface of the substrate; and

a second grating region formed in the top surface of the device material layer on a second portion of the device material layer, the second grating region comprising a plurality of blazed grating structures.

18. The optical device of claim 17, wherein the first and second gratings regions correspond to an input coupling grating and an output coupling grating of a waveguide combiner, respectively.

19. The optical device of claim 17, wherein the plurality of blazed grating structures comprise a blazed surface that is angled relative to the top surface of the substrate.

20. The optical device of claim 17, further comprising a patterned hardmask disposed over the device material layer, the patterned hardmask comprising a transparent material.