CLAIMS:

1. A method for introducing a customized variation of a geometric parameter in a nanoscale pattern on a substrate, the method comprising:

conducting a nanoscale precision programmable profiling process on one or more regions of said substrate having an unpatterned portion of said substrate;

depositing a profiling film with a thickness profile that is a function of said customized variation of said geometric parameter on said unpatterned portion of said substrate to correct for one or more aberrations in said substrate, wherein said customized variation of said geometric parameter is calculated based on measurements of actual aberrations; and

conducting a plasma etch process of said profiling film and material of said nanoscale pattern that converts said thickness profile of said profiling film into said customized variation of said geometric parameter in said nanoscale pattern, wherein said customized variation is a function of said thickness profile of said profiling film.

2. The method as recited in claim 1, wherein said nanoscale pattern is one or more of the following: a 1D diffraction grating, a 2D diffraction grating, a multilevel grating, a slanted grating, a surface relief gratings, a Bragg grating, a volume hologram, and a photonic crystal.

3. The method as recited in claim 1, wherein said substrate is a high-index waveguide substrate, wherein said method is executed on a patterned side of said high-index waveguide substrate, and wherein said nanoscale pattern comprises a diffractive optical element.

4. The method as recited in claim 1, wherein said geometric parameter comprises one or more of the following: a depth or a height of a feature, a lateral width of a feature, and an angle of one dimension with respect to a horizontal plane.

5. The method as recited in claim 1, wherein one or more properties of said customized variation is different for different regions of said nanoscale pattern on said substrate.

6. The method as recited in claim 1, wherein said conducting of said nanoscale precision programmable profiling process and said conducting of said plasma etch process are carried out simultaneously across a plurality of regions of said nanoscale pattern on said substrate.

7. The method as recited in claim 1, wherein said customized variation is achieved in multiple iterations of said conducting of said nanoscale precision programmable profiling process and said conducting of said plasma etch process.

8. The method as recited in claim 1, wherein an average surface roughness of said nanoscale pattern with said customized variation is substantially equivalent to an average surface roughness of said nanoscale pattern without said customized variation.

9. The method as recited in claim 1, wherein a ratio of etch rates of said profiling film and said nanoscale pattern material is substantially matched.

10. The method as recited in claim 1, wherein a ratio of etch rates of said profiling film and said nanoscale pattern material is tunable between 0.05 and 20.

11. The method as recited in claim 1, wherein a customized spatial variation is accomplished in said profiling film using one or more of the following: an inkjet, differential heating with a superstrate, and differential heating without a superstrate.

12. The method as recited in claim 1, wherein said profiling film has an optical property that is substantially matched with said nanoscale pattern.

13. A method for correcting one or more aberrations in a waveguide substrate, the method comprising:

performing a nanoscale precision programmable profiling process on an unpatterned portion of said waveguide substrate by depositing a profiling film on said unpatterned portion of said waveguide substrate with a customized variation to correct for said one or more aberrations in said waveguide substrate, wherein said customized variation to correct for said one or one more aberrations is calculated based on measurements of actual aberrations.

14. The method as recited in claim 13 further comprising:

performing a plasma etch of said profiling film to transfer a desired profile to an underlying material of said profiling film.

15. The method as recited in claim 13, wherein said unpatterned portion of said waveguide substrate lies on a surface of said waveguide substrate that does not contain diffractive optical elements.

16. The method as recited in claim 13, wherein said unpatterned portion of said waveguide substrate has a nanoscale texture.

17. The method as recited in claim 13, wherein said one or more aberrations result from one or more of the following: substrate total thickness variation (TTV) errors and deposition of films.

18. An apparatus for introducing a customized variation of a geometric parameter in a nanoscale pattern on a substrate, the apparatus comprising:

a profiling module, wherein said profiling module has an inkjet for depositing a profiling film on a substrate with a thickness profile that is a function of said customized variation of said geometric parameter in said nanoscale pattern on said substrate, wherein a plasma etch process is conducted on said profiling film and material of said nanoscale pattern that converts said thickness profile of said profiling film into said customized variation of said geometric parameter in said nanoscale pattern to correct for one or more aberrations in said substrate, wherein said customized variation is a function of said thickness profile of said profiling film, wherein said customized variation of said geometric parameter to correct for said one or one more aberrations is calculated based on measurements of actual aberrations.

19. The apparatus as recited in claim 18, wherein said substrate comprises a waveguide substrate, wherein said substrate has a region with an optical element with said customized variation of said geometric parameter in said nanoscale pattern on said substrate.

20. An XR device, the device comprising:

a waveguide that is fabricated using nanoscale precision programmable profiling for introducing a customized variation in a geometric parameter of a nanoscale pattern on said waveguide to correct one or more aberrations, wherein said nanoscale precision programmable profiling comprises: depositing a profiling film with a thickness profile that is a function of said customized variation of said geometric parameter; and conducting a plasma etch process of said profiling film and material of said nanoscale pattern that converts said thickness profile of said profiling film into said customized variation of said geometric parameter, wherein said customized variation of said geometric parameter to correct for said one or one more aberrations is calculated based on measurements of actual aberrations.