CLAIMS:

1. A roll-to-plate nanoimprint lithography process by patterning nanoscale features using a roll-based high volume manufacturing (RHVM) template with nanoscale patterns held in a roll-to-roll configuration on to a substrate, the process comprising:

coating a film of a solution of nanoimprint resist material on said substrate;

performing in-situ alignment of said substrate with said template;

initiating a substantially point or line contact between said template and said substrate;

exercising control over an out-of-plane deflection profile of said template or said substrate;

crosslinking said resist material with UV light while said out-of-plane deflection profile of said template matches a surface profile of a top surface of said substrate; and

separating said template from said substrate through manipulation of motion of said template or said substrate.

2. The process as recited in claim 1, wherein said process is used to fabricate photonic or optical structures.

3. The process as recited in claim 1, wherein a refractive index of said resist material is substantially matched with a refractive index of said substrate.

4. A roll-to-roll nanoimprint lithography process by patterning nanoscale features using a roll-based high volume manufacturing (RHVM) template with nanoscale patterns held in a roll-to-roll (R2R) configuration on to a substrate held in a roll-to-roll configuration, the process comprising:

driving said template and said substrate to be incoming at substantially a same speed and tension;

coating a film of a solution of nanoimprint resist material on said substrate;

initiating a substantially point or line contact between said incoming template and said incoming substrate;

exercising control over an out-of-plane deflection profile of said substrate or said template;

crosslinking said resist material with UV light while said out-of-plane deflection profile of said template matches a surface profile of a top surface of said substrate; and

separating said template from said substrate through manipulation of said substrate or said template.

5. The process as recited in claim 4, wherein said resist material is coated on said substrate using slot-die coating, tensioned-web slot-die coating, kiss gravure coating, micro-gravure coating, doctor blading, knife-edge coating, or a combination thereof to control a residual layer thickness of said resist material.

6. The process as recited in claim 4 further comprising:

performing an application of non-uniform heat flux along an imprinted area of said substrate or said template.

7. A nanoimprint lithography apparatus, the apparatus comprising:

fixtures for mounting coating systems;

an ultraviolet (UV) transparent area;

a module for control of an out-of-plane deflection profile of a template or a substrate;

a stage for mounting said template which allows in-plane and out-of-plane motion of said template or a stage for mounting said substrate which allows in-plane and out-of-plane motion of said substrate;

a module for said substrate or said template held in a roll-to-roll configuration configured to ensure a substantially flat zone for imprinting; and

an evaporation module for evaporating resist material from said template or said substrate.

8. The apparatus as recited in claim 7, wherein said module for control of said out-of-plane deflection profile comprises a vacuum preloaded air bearing.

9. The apparatus as recited in claim 8, wherein portions of said vacuum preloaded air bearing comprises said UV transparent area.

10. The apparatus as recited in claim 8, wherein said vacuum preloaded air bearing contains multiple pressure zones with positive and negative pressures with a range of magnitudes by connecting each pressure zone to electronic flow controllers and pressure regulators.

11. The apparatus as recited in claim 8 further comprising:

distance and orientation measuring sensors and area scan cameras incorporated in said vacuum preloaded air bearings and a mounting system of said template or said substrate.

12. The apparatus as recited in claim 8, wherein said vacuum preloaded air bearing has a flat porous surface adjacent to a flexible web.

13. The apparatus as recited in claim 7 further comprising:

a stage for mounting said module for control of out of plane deflection to allow out-of-plane alignment with said substrate and said template; and

alignment stages for orienting rollers parallel to each other in a roll-to-roll configuration of said template.

14. The apparatus as recited in claim 7, wherein a resting surface for said template or said substrate is one or more of the following: a vacuum chuck with pins with multiple pressure zones, and a vacuum preloaded air bearing to facilitate said out-of-plane defection profile of said template or said substrate.

15. The apparatus as recited in claim 7, wherein said out-of-plane motion of said template or said substrate is achieved through one or more of the following: a piezoelectric actuator, a voice coil motor driven stage with compliant translational and compliant universal joints capable of vertical, tip and tilt motion, and a kinematic stage with manual actuators.

16. The apparatus as recited in claim 7, wherein said evaporation module comprises an infrared heater coupled with a digital micromirror device.

17. The apparatus as recited in claim 7 further comprising:

an at-line metrology module comprising scatterometry and spectral imaging.

18. The apparatus as recited in claim 7 further comprising:

stages configured to control rollers in a roll-to-roll configuration to achieve controlled in-plane or out-plane deformation or rigid body motion of said substrate or said template in said flat zone for imprinting.

19. The apparatus as recited in claim 7 further comprising:

vacuum rollers or nip rollers or a combination thereof configured to drive a template web or a substrate web independently while providing matching speed and tension.

20. The apparatus as recited in claim 7 further comprising:

a nip roller placed downstream of an imprinting area configured to drive both said substrate and said template by applying contact pressure on a drive roller.

21. The apparatus as recited in claim 7 further comprising;

an array of microscopes with light sources and cameras aimed at alignment markers laid down along a portion of an imprinting area, wherein said alignment markers are one or more of the following: Moiré alignment markers and coarse alignment bars.