CLAIMS

1. A method comprising:

forming a patterned layer on a substrate, the patterned layer defining a relief pattern having non-uniformly sized features and further including a transition zone between small and large features;

depositing a conformal hard mask layer by low temperature deposition over the patterned layer features;

applying a non-planar protective layer over the conformal hard mask layer, the protective layer having a planarity efficiency PE of less than 95% (PE 95%) and wherein the protective layer has an etch selectivity $\xi 1$ relative to the conformal hard mask layer of at least 5 ($\xi 1 \geq 5$) under first etch conditions and wherein the conformal hard mask layer has an etch selectivity $\xi 2$ relative to the protective layer of greater than1 ($\xi 2 > 1$) under second etch conditions and wherein the patterned layer has an etch selectivity ξ3 relative to the conformal hard mask layer of at least 5 ($\xi 3 \geq 5$) under third etch conditions ;

selectively etching the protective coating under the first etch conditions to expose the top surface of the conformal hard mask layer extending over the tops of the pattern protruded features;

selectively etching the exposed conformal hard mask layer under the second etch conditions to expose the pattern features thereunder; and

selectively etching the exposed pattern features under the third etch conditions to expose the substrate and form a pattern that is the reverse of the relief pattern.

2. The method of claim 1 wherein the low temperature deposition is atomic layer deposition (ALD).

3. The method of claim 1 wherein the non-planar protective coating has a planarity efficiency (PE) of at least 50% (50% $\leq$ PE < 95%).

4. The method of claim 1 wherein the etch selectivity *ξ2* is at least 2 (*ξ* 2 $\geq$ 20) and the non-planar protective coating has a planarity efficiency (PE) of at least 35% (35% $\leq$ PE < 95%).

5. The method of claim 1 wherein the etch selectivity *ξ2* is at least 5 (*ξ2* $\geq$ 5) and the non-planar protective coating has a planarity efficiency (PE) of at least 20% (20% $\leq$ PE < 95%).

6. The method of claim 1 wherein the etch selectivity *ξ2* is at least 10 (*ξ2* $\geq$ 10) and the non-planar protective coating has a planarity efficiency (PE) of at least 15% (15% $\leq$ PE < 95%).

7. The method of claim 1 wherein the etch differential *ξ2* is at least 20 (*ξ2* $\geq$ 20) and the non-planar protective coating has a planarity efficiency (PE) of at least 10% (10% $\leq$ PE < 95%).

8. The method of any one of claims 1-7 wherein the planarity efficiency is less than 90% or less than 80% or less than 70% or less than 60%.

9. The method of any one of claims 1-7 wherein the conformal hard mask layer has a thickness h_{HM} greater than one-half the space s between the closest features ($h_{HM} \geq s/2$).

10. The method of any one of claims 1-7 wherein the conformal hard mask layer is SiO_2 or Al_2O_3.

11. The method of any one of claims 1-7 wherein the non-planar protective layer is spin-on carbon (SOC).

12. The method of any one of claims 1-7 wherein the pattern comprises clusters of nanometer scaled features separated by micron-sized open areas.

13. The method of any one of claims 1-7 further comprising the steps of selectively etching the exposed substrate to transfer the reverse tone pattern into the substrate, and processing the substrate to manufacture a device.