CLAIMS

What is claimed is:

1. A method of forming a patterned structure on a substrate, the method comprising:

forming a resist layer on the substrate, the resist layer being a negative tone resist; exposing a first portion of the resist layer to a focused electron beam to form a modified first portion, the modified first portion defining a boundary of a second portion of the resist layer;

performing a plasma treatment on a surface of the resist layer, including on a surface of the second portion of the resist layer to form a modified surface portion of the second portion of the resist layer over an unmodified remaining portion of the second portion of the resist layer, resulting in a plasma treated resist surface layer comprising the modified surface portion of the second portion, the modified first portion and the modified surface portion of the second portion of the resist layer being crosslinked dense network structures which together enclose the unmodified remaining portion of the second portion of the resist layer on the substrate; and

performing development using a developer solution with the modified surface portion being over the unmodified remaining portion of the second portion of the resist layer and the modified first portion surrounding the unmodified remaining portion of the second portion of the resist layer for protecting the unmodified remaining portion of the second portion of the resist layer from reacting with the developer solution for forming the patterned structure on the substrate comprising the unmodified remaining portion of the second portion of the resist layer.

2. The method of claim 1, wherein the modified first portion has a loop configuration defining the boundary of the second portion of the resist layer.

3. The method of claim 2, wherein the loop configuration is a closed loop configuration.

4. The method of claim 2 or 3, wherein the loop configuration is a polygon configuration.

5. The method of any one of claims 1 to 4, wherein the modified first portion has a width of at least 100nm.

6. The method of any one of claims 1 to 5, further comprising exposing a third portion of the of the resist layer to the focused electron beam prior to the plasma treatment to form a modified third portion within the modified first portion.

7. The method of any one of claims 1 to 6, wherein the plasma treatment is an oxygen plasma treatment.

8. The method of any one of claims 1 to 6, wherein the plasma treatment is an argon plasma treatment.

9. The method of claim 7, wherein the modified surface portion is an oxidized layer.

10. The method of claim 7, wherein the resist layer is formed of hydrogen silsesquioxane.

11. The method of claim 8, wherein the modified surface portion is a carbonized layer.

12. The method according to any one of claims 1 to 11, further comprising performing ultrasonic agitation of the substrate during said development for removing a residual portion of the plasma treated resist surface layer, wherein the modified first portion provides structural support to the modified surface portion of the second portion during said ultrasonic agitation of the substrate.

13. The method of any one of claims 1 to 11, wherein said performing development of the plasma treated surface resist layer comprises removing an unmodified portion of the resist layer unprotected by the modified first portion of the resist layer.

14. The method of claim 13, further comprising performing an etch to remove a residual of the modified surface portion over the unmodified remaining portion of the second portion of the resist layer.

15. The method of claim 14, further comprising fully crosslinking the unmodified remaining portion of the second portion of the resist layer on the substrate into a dense network structure by a thermal treatment prior to performing the etch.

16. A device comprising a substrate and a patterned structure formed thereon formed by the method comprising:

forming a resist layer on the substrate, the resist layer being a negative tone resist;

exposing a first portion of the resist layer to a focused electron beam to form a modified first portion, the modified first portion defining a boundary of a second portion of the resist layer;

performing a plasma treatment on a surface of the resist layer, including on a surface of the second portion of the resist layer to form a modified surface portion of the second portion of the resist layer over an unmodified remaining portion of the second portion of the resist layer, resulting in a plasma treated resist surface layer comprising the modified surface portion of the second portion, the modified first portion and the modified surface portion of the second portion of the resist layer being crosslinked dense network structures which together enclose the unmodified remaining portion of the second portion of the resist layer on the substrate; and

performing development using a developer solution with the modified surface portion being over the unmodified remaining portion of the second portion of the resist layer and the modified first portion surrounding the unmodified remaining portion of the second portion of the resist layer for protecting the unmodified remaining portion of the second portion of the resist layer from reacting with the developer solution for forming the patterned structure on the substrate comprising the unmodified remaining portion of the second portion of the resist layer.